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ABSTRACT

This two-volume supplementary curriculum is designed for teachers of children grades 4-8. There are eight units overall: (1) national resources; (2) litter; (3) household hazardous wastes; (4) landfills; (5) recycling; (6) incineration; (7) compost; and (8) source reduction. Each unit contains a list of objectives for students, a suggested time frame for the unit, lesson plans for the lessons contained in the unit, a glossary, a unit test and a teacher's guide for each lesson. Lesson plans contain lists of materials, procedures, and suggestions for extension activities. In addition, each unit contains reproducible student worksheets, and overhead transparencies. Units vary from three to ten lessons in length. Lessons are interdisciplinary in nature and involve a number of different activities, and skills including surveys, writing projects, outdoor activities, mathematics skills, science skills, and many others. (CW)

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OSCAR'S OPTIONS

A Supplementary Environmental Education Curriculum

By Carole O. Bell and Martha M. Schwartz

OSCAR
Ocean State Cleanup and Recycling
Department of Environmental Management
Providence, RI 02908

100% Recycled Paper

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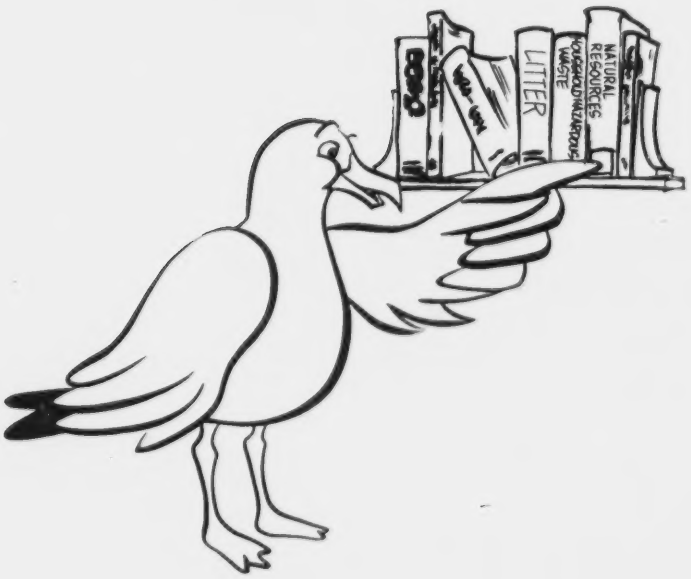
OSCAR'S OPTIONS

UNIT 1

NATURAL RESOURCES



NATURAL RESOURCES

OBJECTIVES

1. Students will be able to define and identify natural resources.

2. Students will recognize that the earth is the ultimate source of everything we use.

3. Students will recognize that resources are renewable or non-renewable, defining and giving examples of each.

4. Students will use population and energy consumption statistics to examine global patterns of resource consumption.

5. Students will learn the definitions of consume and conserve and apply these concepts to the choices they make in their daily lives.

6. Students will read or listen to an environmental fable and understand the concept of an ecosystem. Students will be able to draw conclusions and make predictions about the environmental impact of certain human behaviors.

7. Students will participate in a game to determine the effects of human behaviors on different natural resources. They will make informed decisions and propose alternative solutions to various situations.

8. Students will apply their understanding of natural resources, consumption and conservation to a creative writing project.

ACTIVITIES

I.	Planet Earth – Rich in Resources	Introduction
II.	Everything Comes From the Earth	Research and Art Activity
III.	Will We Ever Run Out?	Science and Reading Activity
IV.	How Much Do We Use?	Math Activity Simulation Game
V.	Consume/Conserve	Creative Thinking Activity
VI.	Legend of the Lorax	Reading Activity
VII.	It's YOUR Environment!!	Group Science Activity
VIII.	Garbage Tales	Creative Writing Activity

TEACHER INFORMATION

These lessons were written with Grades 4 - 8 in mind. All student materials are written at a 6th grade reading level. The lessons in this unit are arranged sequentially, but individual lessons may be taught or deleted as best suits you and your class.

POSSIBLE IMPLEMENTATION OF NATURAL RESOURCES UNIT

Monday:	I. Introduction and	
	II. Research/Art Activity	35 min.
	III. Science and Reading Sheet (Homework)	30 min.
Tuesday:	IV. Math Activity and Simulation Game	40 min.
	V. Creative Thinking Sheet (Homework)	30 min.
Wednesday:	VI. Reading Activity	40 min.
Thursday:	VII. Science Simulation Game	30 min.
Friday:	VIII. Creative Writing Activity	30 min.

Lesson I.

PLANET EARTH – RICH IN RESOURCES
Introduction

Students will be able to define and identify natural resources.

MATERIALS NEEDED
Student worksheet (one per child)

BACKGROUND
Natural resources have taken billions of years to form on the planet Earth. Human consumption is depleting these supplies rapidly, with some resources already scarce and others expected to run out within the next century. Natural resources include: air, water (salt and fresh), soil and rock (marble, quartz, limestone, granite, clay, topsoil, loam, sod, sand), minerals and precious metals (Mercury, Copper, Tungsten, Aluminum, Silver, Molybdenum, Cobalt, Tin, Zinc, Nickel, Lead, Platinum, Manganese, Iron, Gold, Chromium), fossil fuels (coal, oil, natural gas), plant forms and wildlife.

IMPLEMENTATION
Distribute student worksheet and discuss natural resources with students. Reinforce the concept by dividing class into four groups and telling each group to list as many specific natural resources as they can in a two minute period (see above). Compare and discuss group lists. Help children to recognize the interrelatedness of these resources, through discussion.

EXTENSION
Using reference books and outline maps, have students locate and label sites where specific natural resources (especially minerals, precious metals and fossil fuels) are plentiful.

Students may conduct investigations into the source, use, and anticipated supply of various natural resources (see above list).

VOCABULARY
natural resources
infinite
finite
limited

PLANET EARTH – RICH IN RESOURCES

The earth gives us the things we need for life. We have air to breathe, water to drink and soil to grow our food. These things, plus all the other materials that people consider useful, are called natural resources. They all come from the earth. They were once part of the rocks, oceans, animals or plants with which we share our planet. The resources may be mined from the ground, harvested from the forests or fields, or removed from the atmosphere and oceans. Oil, coal, precious metals, wildlife, soil, water and air are all natural resources.

Since all of these things come from the earth, they are all connected. What happens to one resource may affect some or all of the other resources. We must take care of the earth.

Lesson II.

EVERYTHING COMES FROM THE EARTH
Research and Art Activity

Students will recognize that the earth is the ultimate source of everything we use.

MATERIALS NEEDED
One egg, fork, reference books about natural resources, small drawing paper or index cards, crayons, string or thread, sticks or coat hangers, overhead projector

BACKGROUND
Aluminum Can – aluminum is made from a clay, bauxite, which is a non-renewable resource. Bauxite ore is mined in Australia and Brazil and shipped at great expense to its prime consumers, the United States and the Soviet Union. In the U.S., aluminum is extracted from the bauxite. Thousands of kilowatt hours of electricity are expended in this extraction, and the process creates a significant amount of waste material. For each ton of aluminum, four to five tons of waste rock are left over. One factory produces sheet aluminum, which is then shipped to another factory where beverage cans are cut from the sheets.

Plastic Bag – most modern plastics have petroleum, a non-renewable resource, as their primary raw material, but plastics are made from innumerable other materials, as well. The earliest plastics were made from cellulose, a plant fiber, which is still the basis for film, audio and videotape. Plexiglass is produced from petroleum, coal, air and water. Plastic bags and phonograph records are derived from a mixture of petroleum and chlorine.

Leather Shoes – real leather is made from the skin of animals which eat grasses which grow in the soil. Note that many modern items which appear to be made of leather are actually vinyl, which is a kind of plastic. Animals represent a renewable resource.

Wooden Chair – the chair is manufactured from trees which grow in the earth. Trees are a renewable resource.

Cotton Jeans – bolls of cotton grow on plants throughout the southern United States. The cotton must be picked, cleaned, carded, made into yarn or thread, woven into cloth, dyed the appropriate color, cut and sewn into jeans, distributed to stores and sold. Cotton itself is a renewable resource, but a great deal of energy is expended to convert it into a pair of jeans.

Newspaper – paper is made from wood, and trees are a renewable resource. The basic ingredient of paper is wood pulp, soft wood broken down either by chemical process or by grinding until the cellulose fibers separate. Chemically produced pulp is made into good quality writing paper; ground wood pulp is used for newsprint. The pulp is washed and screened, then mixed with water in a beater. During the beating process, colored dyes or chemical sizing may be added. The mixture is then screened and shaken to remove the water, pressed and dried over a series of hot cylinders and wound into a roll of paper.

Steel Scissors – steel is made from iron ore, a non-renewable resource. Iron ore is mined and then transported to a steel manufacturing plant. The ore is then broken into small pieces and heated into a fuel, called coke, which melts it. After the iron separates from other materials in the ore, limestone is added to combine with the waste ore. At temperatures above 2800° Fahrenheit, the limestone/waste ore mixture floats to the surface while the melted iron sinks to the bottom of the furnace. This melted iron, called Pig Iron, is purified in an oxygen furnace which converts the metal into steel. Melted steel is then poured off and shaped.

Glass Bottle – glass is made by melting silica, a fine, white sand, in combination with soda (sodium carbonate), or small pieces of old broken glass called cullet. Either soda ash or cullet will help the silica melt faster; lime (calcium carbonate) is sometimes added, also. The silica melts in a furnace at temperatures above 2600°. Silica is a non-renewable resource.

Hamburger – the meat is beef which is the flesh of the cow (see Leather). The bun is made from grains which grow in the ground. These are the same grains that provide food for the cow. Both the cow and the grains are renewable resources.

IMPLEMENTATION

Display the egg to students and ask them to think about the natural resources used to create it. Help students to recognize that an egg comes from a chicken, the chicken eats grain and grain is grown in the soil which is nourished by sunlight and water.

Display a fork to students and tell them that everything we use comes from the earth, though we may not recognize that by looking at the manufactured forms of certain items. Explain that in fact, we spend a great deal of time and energy finding our natural resources and changing them to make them useful to us. Example: in producing steel to make the fork, a large amount of rock containing a small amount of iron must be mined first. Energy-consuming machinery separates the iron from the rock, then the iron ore is purified with oxygen to make steel. The finished steel must be transported from the point of manufacture to the point of use.

List these items on the chalkboard: aluminum can, sandwich bag, leather shoes, wooden chair, cotton jeans, newspaper, steel scissors, glass bottle, hamburger. Divide class into small groups and assign one item from the list to each group. Instruct teams to investigate their item until they have discovered in what form the item comes from the earth. Assist younger children in determining key words to facilitate research in reference books.

Tell students that they are going to create mobiles to show what they have learned through their investigations. Provide materials and instruct each team member to complete a drawing illustrating one phase of the process so that, when constructed, the mobile tells the story of how that item comes from the earth. The natural resources used to produce the item should be shown on the mobile.

EXTENSION

Worksheet could be completed independently.

Older students may include manufacturing, processing and transportation as additional illustrations on their mobiles.

VOCABULARY

manufacturing
mining

NAME _____

EVERYTHING COMES FROM THE EARTH

Identify the steps along the way which have changed the items listed. Try to trace each item back to its original source, the earth. For example, the egg you had for breakfast was once inside a chicken, which ate corn and other grains, which grew in the earth, so:

EGG – CHICKEN – GRAINS – EARTH

ALUMINUM CAN

PLASTIC BAG

LEATHER SHOES

WOODEN CHAIR

COTTON JEANS

NEWSPAPER

STEEL SCISSORS

GLASS BOTTLE

HAMBURGER

CAN YOU NAME ONE THING THAT DOES NOT COME FROM THE EARTH?

EVERYTHING COMES FROM THE EARTH

Identify the steps along the way which have changed the items listed. Try to trace each item back to its original source, the earth. For example, the egg you had for breakfast was once inside a chicken, which ate corn and other grains, which grew in the earth, so:

EGG – CHICKEN – GRAINS – EARTH

ALUMINUM CAN
can-sheet aluminum-aluminum-bauxite-earth

PLASTIC BAG
plastic-petroleum-earth

LEATHER SHOES
shoes-leather-cow/pig, etc.-grains-earth

WOODEN CHAIR
chair-lumber-tree-earth

COTTON JEANS
jeans-thread-cotton plant-earth

NEWSPAPER
paper-wood-tree-earth

STEEL SCISSORS
scissors-steel-iron ore-earth

GLASS BOTTLE
glass-silica/sand-earth

HAMBURGER
bun-grains-earth meat-cow-grains-earth

CAN YOU NAME ONE THING THAT DOES NOT COME FROM THE EARTH?
no

Lesson III

WILL WE EVER RUN OUT?
Science and Reading Activity

Students will recognize that resources are renewable or non-renewable, defining and giving examples of each type.

MATERIALS NEEDED
Student worksheet (one per child)

SOURCE
THE GREAT GARBAGE MACHINE

BACKGROUND
SEE ANSWER SHEET

IMPLEMENTATION
Distribute student worksheet and discuss the text, defining renewable and non-renewable resources.

Give students time to complete the written activity and challenge them to list 5 (or 10! or the longest possible list!) things made from renewable resources and a similar number of items made from non-renewable resources on the back of the paper.

VOCABULARY
renewable
non-renewable
limited
unlimited

NAME _____

WILL WE EVER RUN OUT?

Some resources come from plants and animals which grow and reproduce. These can slowly be replaced if we use such resources wisely and plan ahead for the future. If we cut down a tree to make lumber, paper or cardboard, we could plant a new tree. Since more trees can be grown, trees are called a renewable resource. Crops, animals and other things which can be replaced are renewable.

But there are some resources which cannot be replaced. A limited amount is found on the earth. When it is gone, there will be no more. These resources are non-renewable. We can't grow or make new copper or other precious metals. When the last oil well runs dry, there will be no more oil for heat, for cars or for use in all of the plastic products which are now part of our lives. Minerals, fossil fuels, water and air are all non-renewable.

IDENTIFY THE RESOURCE WHICH IS USED TO MAKE EACH ITEM. THINK ABOUT WHETHER THAT RESOURCE CAN GROW SO THAT WE WILL HAVE MORE. MARK AN 'R' NEXT TO THOSE ITEMS, BECAUSE THE SOURCE IS RENEWABLE. MARK AN 'NR' NEXT TO THE ITEMS WHICH ARE MADE FROM SOURCES THAT CAN'T BE REPLACED. THEY ARE NON-RENEWABLE.

cardboard box	_____	aluminum pan	_____
steel bucket	_____	drinking glass	_____
copper pipe	_____	steak	_____
book	_____	corn on the cob	_____
leather jacket	_____	wool sweater	_____
wooden desk	_____	tire	_____
cotton shirt	_____	diamond ring	_____
polyester shirt	_____	plastic wastebasket	_____

Teacher's Page

WILL WE EVER RUN OUT?

Some resources come from plants and animals which grow and reproduce. These can slowly be replaced if we use such resources wisely and plan ahead for the future. If we cut down a tree to make lumber, paper or cardboard, we could plant a new tree. Since more trees can be grown, trees are called a renewable resource. Crops, animals and other things which can be replaced are renewable.

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cardboard box	tree – R	aluminum pan	bauxite – NR
steel bucket	iron – NR	drinking glass	sand/silica – NR
copper pipe	copper – NR	steak	animal – R
book	tree – R	corn on the cob	plant – R
leather jacket	animal – R	wool sweater	sheep – R
wooden desk	tree – R	tire	rubber tree – R
cotton shirt	plant – R	diamond ring	diamond,gold – NR
polyester shirt	oil – NR	plastic wastebasket	oil – NR

Lesson IV

HOW MUCH DO WE USE?
Math Activity/Simulation Game

Students will use population and energy consumption statistics to examine global patterns of resource consumption.

MATERIALS NEEDED
Bag of unshelled peanuts, signs for 7 continents, seven 10-foot-long pieces of yarn, each tied in a loop, overhead projector.

SOURCE
Adapted from FOOD FOR THOUGHT

BACKGROUND
Due to our industrial lifestyle, U.S. citizens consume far more energy on a per capita basis than do people residing in other countries. We have only 6% of the world's population, yet we consume one-third (33%) of the world's energy via industrial, commercial, residential, and transportation demands.

IMPLEMENTATION
Explain to students that the world population is distributed among the continents and islands of our planet in an uneven manner. Lay out loops of yarn in different areas of the classroom. Label them with the names of the seven continents (North America, South America, Europe, Asia, Africa, Australia and Antarctica), explaining that Antarctica is not inhabited on a permanent basis. Explain that you will divide up the class to represent the population of each continent. Help students to compute the mathematical work necessary in order to apportion the following percentages of the class population to each continent: North America 8.5%, South America 5.6%, Europe 17.1%, Asia 58%, Africa 10.4%, Australia .3%. (Thus, in a class of 25 students, the continents would be represented by 2, 1, 4, 15, 3, 0.)

You may wish to explain that certain countries have more people than others, with China's population the greatest at 1.05 billion (21.3% of the world total). India has 785 million; USSR, 280 million and the US, 241 million. Also, some continents are more crowded than others, as large numbers of people live in comparatively small spaces. Density ranking is: Europe (196 people per square mile), Asia (142), North America (38.5), South America (35), Africa (31) and Australia (5).

Display the bag of peanuts to students and tell them that this represents the amount of energy available on the earth. Remind students that fossil fuels are a finite resource. Divide the bag in half, putting one half on a table to represent remaining supplies. Tell students that, due to differing lifestyles, countries consume varying amounts of energy.

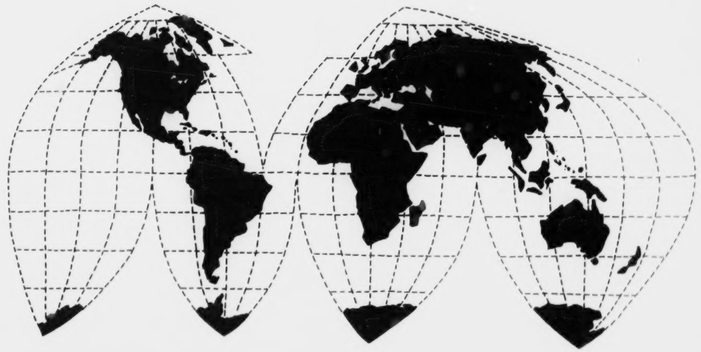
Each student will be allotted a number of peanuts, depending upon the energy consumed on their continent. Have 1 peanut represent 1000 kilograms of energy consumption, rounding off figures to the nearest thousand. Assist children in apportioning peanuts to each continent, further dividing students to represent specific countries. That is, some students in Asia should receive one peanut (for China), others two (for Japan), others four (for the USSR) and others zero (for India). Each student in North America should receive 8 or 10 peanuts. Return any extra peanuts to the pile on the table.

Discuss this inequity with students, as they compare each of their portions. Draw attention to the remaining peanuts. Assist students in drawing conclusions about our consumption of natural resources, specifically, that the industrialized nations will quickly use up the remaining resources.

Display the following figures:

Energy consumption in kilograms per resident

North America		Africa	
Canada	8060	Algeria	421
USA	9828	South Africa	2687
South America		Libya	390
Brazil	392	Asia	
Chile	1163	China	726
Europe		USSR	3957
Poland	3642	India	176
Turkey	422	Japan	2323
United Kingdom	5003	Australia	
		Australia	4791



Lesson V

CONSUMERS/CONSERVERS
Creative Thinking Activity

MATERIALS NEEDED
Student worksheet (one per child)

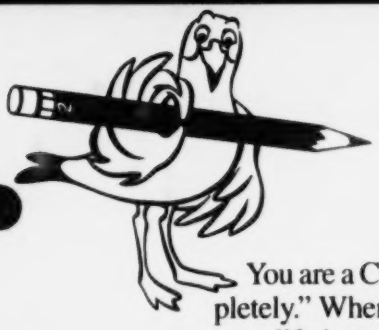
BACKGROUND
The increasing rate at which resources disappear and the rising mound of waste we have to dispose of are a direct result of the ways we use our resources in our daily lives. Americans, on a per person basis, consume far more energy, food and other natural resources than do people in other parts of the world.

There has already been serious environmental damage caused by improper use of our natural resources. Mineral resources such as lead, zinc and copper are near depletion. Natural gas and oil are disappearing rapidly. Experts believe that we will run out of these fossil fuel supplies in 30-40 years, and our coal supply will be exhausted by the year 2400. Pollution threatens our supplies of air, water and soil. If we want to conserve resources for the generations to come and improve our present environment, we must make informed choices as to how we use our natural resources today.

IMPLEMENTATION
Write CONSUME and CONSERVE on the board. Have students attempt to define both terms, and to give examples of things which they consume or conserve. Record the lists on the board. Compare the lengths of the lists and discuss with students the resulting problem (i.e., we consume more than we conserve).

Distribute student worksheet. Have students complete the activities, independently, prior to a class discussion. Note: answers are provided as guidelines and suggestions. Encourage detailed and creative thinking among students and discuss with them the problem that, in many cases, there aren't any "right" answers – there are trade-offs and values to be weighed as we consume different natural resources.

VOCABULARY
consume
conserve
disposable
reuse



NAME _____

CONSUME/CONSERVE: the choice is yours!

You are a CONSUMER! Consume is a verb which means "to do away with completely." When you consume something you use it up, eat it, wear it out, or finish it. In your lifetime, you have consumed hundreds of peanut butter sandwiches, gallons of water, and dozens of pairs of socks.

LIST SOME THINGS THAT YOU PERSONALLY CONSUME IN ONLY ONE USE (for example, your carton of milk at lunch or a piece of paper you've drawn a picture on).

_____

_____

LIST SOME THINGS THAT ARE USED MANY TIMES BEFORE THEY ARE CONSUMED (such as your shoes, or a coloring book).

_____

_____

You can CONSERVE. Conserve means to preserve, keep safe, or use wisely. You are a conserver when you are not wasteful.

LIST SOME THINGS THAT ARE MADE TO BE USED ONLY ONCE AND THEN THROWN AWAY.

_____

_____

LOOK AT YOUR LIST. SUGGEST SOME OTHER PRODUCTS OR USES THAT MIGHT DO THE SAME JOB WHILE CONSERVING OUR RESOURCES.

_____

_____

Are there some changes that YOU could make in your lifestyle that would conserve our resources? List them!

_____

_____

Teacher's Page

CONSUME/CONSERVE: the choice is yours!

You are a CONSUMER! Consume is a verb which means "to do away with completely." When you consume something you use it up, eat it, wear it out, or finish it. In your lifetime, you have consumed hundreds of peanut butter sandwiches, gallons of water, and dozens of pairs of socks.

LIST SOME THINGS THAT YOU PERSONALLY CONSUME IN ONLY ONE USE (for example, your carton of milk at lunch or a piece of paper you've drawn a picture on).

paper products, food, toothpaste, gasoline, electricity

LIST SOME THINGS THAT ARE USED MANY TIMES BEFORE THEY ARE CONSUMED (such as your shoes, or a coloring book).

toothbrush, hairbrush, clothing, television, car, games, furniture, computer, telephone

You can CONSERVE. Conserve means to preserve, keep safe, or use wisely. You are a conserver when you are not wasteful.

LIST SOME THINGS THAT ARE MADE TO BE USED ONLY ONCE AND THEN THROWN AWAY.

paper towels, soda can, bottle, paper napkins, packaging, paper plates, plastic silverware, newspapers, disposable diapers, plastic trash bags

LOOK AT YOUR LIST. SUGGEST SOME OTHER PRODUCTS OR USES THAT MIGHT DO THE SAME JOB WHILE CONSERVING OUR RESOURCES.

cloth towels – wash and reuse, recycled containers, cloth napkins, more thoughtful (less) packaging, china, metal silverware, TV newscast, cloth diapers, trash cans

Are there some changes that YOU could make in your lifestyle that would conserve our resources? List them!

Recycle aluminum cans and newspaper; choose glass or aluminum containers instead of plastic; reuse brown paper lunch bags; encourage parents to choose paper rather than plastic bags at the grocery store; choose a shower instead of a bath and always turn the water off when you brush your teeth

Lesson VI

LEGEND OF THE LORAX
Reading Activity

Students will read or listen to an environmental fable and understand the concept of an ecosystem. Students will be able to draw conclusions and make predictions about the environmental impact of certain human behaviors.

MATERIALS NEEDED
The Lorax by Dr. Seuss, student worksheet (one per child)

BACKGROUND
In *The Lorax*, Dr. Seuss introduces the "Once-ler" who cuts down the beautiful Truffula trees so that he can use their wonderful silk tufts to knit "thneeds". Thneed sales are so successful that the Once-ler builds a factory and invents the Super Axe Hacker which cuts down four trees at a time. The Lorax speaks up in defense of the trees, animals, air and water that the Once-ler is destroying in pursuit of bigger and bigger profits. Finally, when the last Truffula tree is cut down, production of thneeds ends. Closed factories, polluted air, polluted water and an uninhabitable wasteland are all that remain on the once beautiful site. The Lorax can no longer live here, but he leaves behind a small pile of rocks on which the word UNLESS is inscribed.

The Lorax illustrates an ecosystem, a natural unit in which living and non-living parts interact. All of the parts are linked together and function as a unit. When one of the parts is altered or damaged, the entire system may fail.

Consider the ecosystem of Lake Erie, once an important commercial fishing site. Over time, phosphates and other pollutants were discharged into the lake by local industries and sewage treatment facilities. Gradually, the quality of the water was altered. Green plants thrived in the resulting high phosphate environment, but crustaceans and other organisms died. As the number of plants increased, they used up more and more oxygen. Bacteria feeding on the decaying organisms and the continuing chemical discharge enhanced the oxygen depletion. Without oxygen, many of the fish died. Most of the birds which fed on the fish left the area. Finally, Lake Erie was unable to support many of the forms of life that normally lived there. Lake Erie died.

IMPLEMENTATION
Students should read, or have read to them, *The Lorax*, and then complete the questions on the worksheet individually. Focus the follow-up discussion on the concept of an ecosystem and note how each step of the Once-ler's developing business removed a piece of the ecosystem until the entire system ceased to function.

Encourage students to speculate on:
- Why the Super Axe Hacker was invented
- Why the Once-ler ignored the Lorax's warnings
- What happens to the Lorax
- What the Lorax's message "UNLESS" means

EXTENSION

Have children write poems about real forests and the wildlife which inhabit them.

Distribute drawing paper for before and after pictures of the Truffula-tree forest.

Have children create a collage of thneeds (things we think we need), either as a class project or individually, by cutting pictures from magazines.

Create ads for Natural Resources, modeled after the Once-ler's Ad for the Thneed:

"A Thneed's a Fine-Something-That-All-People-Need.
It's a shirt. It's a sock. It's a glove. It's a hat.
But it has other uses. Yes, far beyond that.
You can use it for carpets. For pillows! For sheets!
Or curtains! Or covers for bicycle seats."

Encourage students to discuss the ways we use Natural Resources and to emphasize their value in our lives.

Instruct children to draw diagrams or flow charts of the steps involved in the production of thneeds, accompanied by diagrams displaying the process of manufacturing iron or other precious metals.

Have students illustrate their needs and wants as contrasting pictures.

Plant something or raise money for a tree to be planted on the schoolgrounds in honor of the Lorax and in memory of your class.

VOCABULARY

pollution
ecosystem
interrelated

NAME _____

THE LORAX

1. Why did the Once-ler cut down the Truffula trees?

2. Why do the Brown Bar-ba-loots have to leave?

3. What kinds of problems does the Thneed factory cause for the environment? Name at least three.

4. What happens to the Once-ler when there are no more Truffula trees?

5. What happens to the Lorax?

6. What do YOU think the Lorax's message "UNLESS" means?

7. What could the Once-ler have done to minimize his factory's effect on the environment?

8. Is bigger always better? Give an example to back up your opinion.

9. A "Thneed" is defined as a fine thing that everyone *thinks* they need. What are some examples of thneeds – things that we think we need?

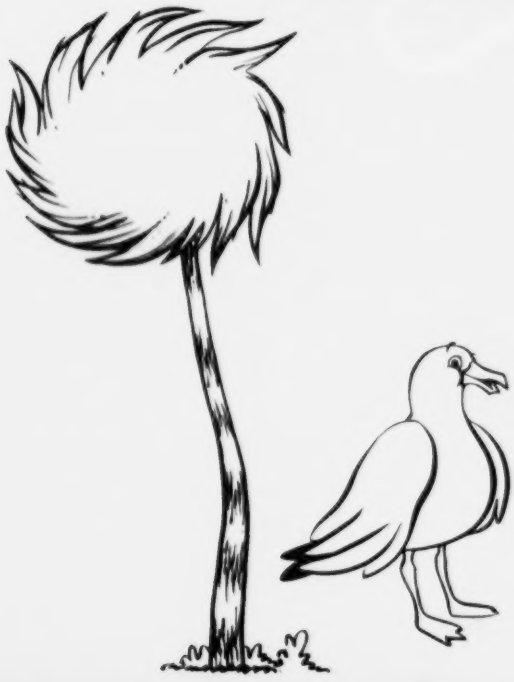
10. The Lorax spoke for trees "for the trees have no tongues". What would you choose to speak for, and what would you say? Plan a one minute talk on behalf of something which cannot speak for itself.

Teacher's Page

THE LORAX

1. Why did the Once-ler cut down the Truffula trees?
   The Once-ler uses the Truffula tufts to make Thneeds.
2. Why do the Brown Bar-ba-loots have to leave?
   Truffula fruit, their main food, becomes scarce when Truffula trees are cut down.
   The Bar-ba-loots get crummy tummies from hunger.
3. What kinds of problems does the Thneed factory cause for the environment? Name at least three.
   Created smog, polluted pond, cut down all trees, forced wildlife relocation
4. What happens to the Once-ler when there are no more Truffula trees?
   Manufacturing ends, the factory closes down and all the Once-ler's relatives leave.
   The Once-ler lives alone at the top of his store.
5. What happens to the Lorax?
   He leaves the forest forever.
6. What do YOU think the Lorax's message "UNLESS" means?
   Students should mention the need for future generations to care for the earth.
7. What could the Once-ler have done to minimize his factory's effect on the environment?
   Install air pollution and water pollution safeguard devices, replant Truffula trees continuously.
8. Is bigger always better? Give an example to back up your opinion.
   Student opinion
9. A "Thneed" is defined as a fine thing that everyone *thinks* they need. What are some examples of thneeds – things that we think we need?
   Answers will vary. Students may mention some of the items which advertising persuades us to buy which quickly become outdated, such as Cabbage Patch dolls.
10. The Lorax spoke for trees "for the trees have no tongues". What would you choose to speak for, and what would you say? Plan a one minute talk on behalf of something which cannot speak for itself.

    Answers will vary. Encourage students to consider a wide variety of natural resources.



Lesson VII

IT'S YOUR ENVIRONMENT!
Group Science Activity/Simulation Game

Students will participate in a game, identifying the ecological impact of human behaviors on different natural resources.

MATERIALS NEEDED
Natural Resource cards, 1 per group

SOURCE
ECOLOGICAL OUCH!

IMPLEMENTATION
Tell students that they are going to play a game which will help them think about our natural resources and how human activities impact upon them. Divide the class into six groups. Give each group a "Natural Resource" card and allow them time to read and examine the card. Explain that each group will take the role of the resource described on the card and will be responsible for protecting that resource.

Read individual situations to the class. Students should be instructed to listen carefully to each situation which you describe. They should consider the situation in terms of the following questions:

1. How does this help your natural resource?
2. How does this harm your natural resource?
3. In situations 1-5, representing your natural resource, are you for or against this idea? Brainstorm alternative solutions to the problems presented in 6-10.

Perhaps these questions should be written on the board. Allow each group to cast a single vote. Encourage discussion within the groups and among the entire class.

EXTENSION
Prepare copies of Natural Resource cards and Situations for students. Have students apply their understanding, individually, by addressing in writing the effects of one situation on all six natural resources, or several situations on one natural resource.

NATURAL RESOURCE CARDS

AIR Clean air is needed by all forms of life. Any smoke or chemicals which enter the air cause air pollution. Protect the air from any and all forms of pollution.

FORESTS AND PLANTS Plants are an important natural resource. They are beautiful. They help to purify our air through the oxygen they give off in photosynthesis. We need plants for food and medicine. Plants are also a source of food and shelter for animals. Protect the plants and the forests.

WATER Fresh water has two important jobs. It is home to many life forms and living creatures must drink it to survive. Salt water also supports many forms of life. Protect both kinds of water.

WILDLIFE, FISH, BIRDS AND INSECTS Fish and wildlife give us many foods and other products. They provide recreation such as nature study and fishing. Many birds and insects pollinate our fruits and vegetables. We must protect them.

SOIL AND MINERALS Soil nurtures all forms of plant life. It contains the minerals and nutrients needed by all living things. There is a limited supply of minerals on the earth. Protect the soil and its minerals.

PEOPLE Are human beings a natural resource? We are part of many food chains. We affect the ecological balance of the earth. We consume natural resources. Think about what is best for the people today. Plan for the future generations who will inherit the earth from us.

SITUATIONS

1. HOUSING DEVELOPMENT Builders want to put up a new housing development on the only undeveloped land in your town. It will have 225 houses and paved streets. The 75 acre tract of land is a meadow and a grove of pine trees right now.

2. PESTICIDES The forests of Rhode Island are being destroyed by gypsy moths. People want the state to spray a powerful pesticide from the air to save the trees. Many scientists think that spraying will not stop the gypsy moths.

3. LUMBERING Every year the state allows people to cut and remove dead trees from the state parks and forests. These dead trees are used for firewood. People use chain saws to cut up the wood.

4. HUNTING A herd of deer live on Prudence Island. There is not enough food so some deer starve each winter. The state has allowed hunters to kill deer to reduce the population.

5. HIGHWAYS The plan to widen Route Six will bring more traffic through northern Rhode Island. It will make the trip to Hartford faster and easier and create more business along the way. Large trucks will pass the Reservoir from which we get our water. Some of them will be carrying dangerous materials.

6. WATER POLLUTION Each time we have heavy rain storms, our sewers overflow. The untreated sewage pours into Narragansett Bay. Runoff from streets and parking lots is washed into the bay, too. Oil from leaky cars and careless oil changes is in this runoff.

7. HAZARDOUS WASTE In the woods, hikers found leaky barrels filled with hazardous waste. They are upstream from the Scituate Reservoir. More than fifty per cent of the people in Rhode Island get drinking water from the Reservoir.

8. FERTILIZER On sunny, spring weekends, people care for their lawns and gardens. Many spread fertilizer. Some use poisons to kill weeds and insects. Rainy Mondays wash these materials into nearby ponds and streams.

9. FIRE A hiker in a state park tossed away a cigarette while in the woods. It was not fully out. It smoldered on dry pine needles for several hours and then became a powerful fire.

10. POWER PLANT An electric power plant which supplies your town with electricity burns coal. Coal gives off gases which produce acid rain. The acid rain falls on our farms and forests and into our streams and lakes.

Lesson VIII

GARBAGE TALES
Creative Writing Activity

Students will apply their understanding of natural resources, consumption and conservation to a creative writing project.

MATERIALS NEEDED
Student worksheet (one per child), pencils, markers and crayons

IMPLEMENTATION
Distribute worksheet. Encourage students to think of creative responses. Help them to utilize this activity as a review of the concepts previously studied, stressing the steps involved in production as well as consumption.

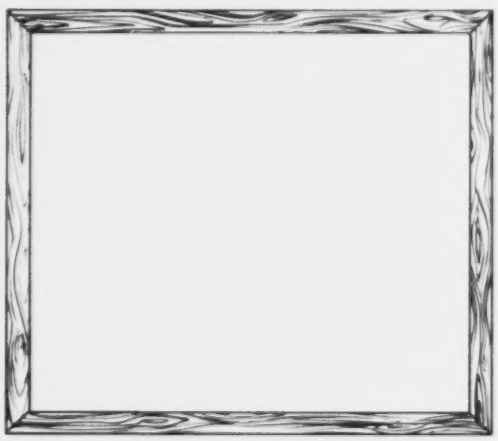
Allow ample time for students to write and illustrate their stories. Share some of the stories with the class.

NAME _____

GARBAGE TALES

Pretend that you are an object that has been discarded in the trash can. Write your life story: how you were made (or grown), your previous owner (user) or owners, how you were consumed and how you ended up in your present predicament. What do you think will happen to you now?

Portrait of _____



NATURAL RESOURCES
UNIT EVALUATION

NAME _____

1. What is a natural resource?

2. Name three natural resources.
   a)
   b)
   c)

3. Define renewable resource.

4. Name two renewable resources.
   a)
   b)

5. Define non-renewable resource.

6. Name two non-renewable resources.
   a)
   b)

7. Which country consumes the greatest amount of energy per person?

8. Define conserve. Name a resource that we could conserve and how we could do it.

9. How are the resources in an ecosystem interrelated?

10. On the basis of what you have studied in this unit, what is the ultimate source of the natural resources that we use?

Teacher's Page

NATURAL RESOURCES
UNIT EVALUATION

1. What is a natural resource?
   valuable naturally occurring materials

2. Name three natural resources.
   possible answers include: air, water, soil, rock, minerals, metals, fossil fuels, plants and wildlife

3. Define renewable resource.
   a resource which can be replaced naturally, derived from an endless source

4. Name two renewable resources.
   a) plant forms
   b) wildlife

5. Define non-renewable resource.
   a resource which occurs in a finite amount

6. Name two non-renewable resources.
   possible answers include: fossil fuels, metals, minerals, water

7. Which country consumes the greatest amount of energy per person?
   United States

8. Define conserve. Name a resource that we could conserve and how we could do it.
   Conserve means to use wisely. Answers will vary.

9. How are the resources in an ecosystem interrelated?
   All the parts are linked together and function as a unit. When one part is altered or damaged, the entire system may fail.

10. On the basis of what you have studied in this unit, what is the ultimate source of the natural resources that we use?
    the earth

NATURAL RESOURCES
VOCABULARY

conserve – to protect from loss, to avoid wasteful or destructive use of

consume – to eat or drink up, to use up

disposable – designed to be used once and then thrown away

ecosystem – a unit or system made up of a community of living things and the physical and chemical environment with which they interact

finite – existing or enduring for a limited time only

infinite – existing without boundaries or limits

interrelated – having a mutual or shared relationship

limited – confined within limits, restricted

manufacturing – make or process a raw material into a finished product

mining – to excavate the earth in order to remove minerals or ore

natural resources – valuable, naturally occurring materials such as timber, fresh water, or a mineral deposit

non-renewable – unable to be restored or made new

pollution – harmful substances deposited in air, water or land, causing contamination

renewable – derived from an endless source, able to be made new or restored

reuse – to extend the life of an item by creating new uses for it

unlimited – having no limits, bounds or qualifications

Clapper, Willard "Ecological Ouch!" in *Environmental Education in the Elementary Schools*. National Science Teachers Association, 1977.

Dahlin, Marge, and Murphy, Elaine. "Food For Thought." Developed for the *Population Education Project*. Washington, D.C.: Zero Population Growth.

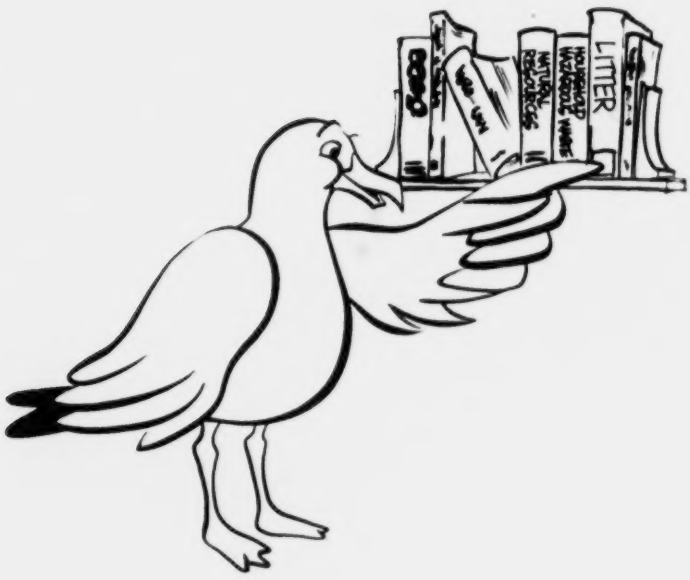
The Great Garbage Machine. Toronto, Ontario: Waste Management Advisory Board.

Mitchell, James, ed. *The Random House Encyclopedia*. New York: Random House, 1977.

OSCAR'S OPTIONS

UNIT II

LITTER



LITTER

OBJECTIVES

1. Students will be able to define litter and name several sources of litter.
2. Students will identify some of the problems resulting from careless disposal of waste.
3. Students will conduct a survey to determine the litter habits of their peers.
4. Students will predict the location of litter in the schoolyard and apply their predictions to a map.
5. Students will observe litter, both natural and manmade, in the schoolyard. By gathering and discussing, they will come to understand the variety and sources of litter.
6. Students will make inferences about the types and sources of highway litter.
7. Students will identify the problems associated with excess packaging.
8. Students will make choices concerning packaging options.
9. Students will discuss the rationale for rules/laws in our society.
10. Students will examine the Rhode Island litter law and analyze its effectiveness.
11. Students will identify ways that litter can adversely affect wildlife and devise potential solutions to real life situations.

ACTIVITIES

I. LITTER – WHAT'S THE PROBLEM?	Introduction
II. TRASH STUDY	Survey
III. LITTER – IT'S EVERYWHERE!	Predicting and Mapping
IV. TRASH TREASURE HUNT	Outdoor Science
V. LITTER ON OUR HIGHWAYS	Math and Language Arts
VI. THE PACKAGING PROBLEM	Analyzing
VII. PACKAGING – HOW MUCH IS TOO MUCH?	Reading and Decision Making
VIII. LITTERING – IT'S AGAINST THE LAW!	Values Discussion and Writing
IX. LITTER AND ANIMALS	Group Problem Solving
X. OIL AND WILDLIFE	Science

TEACHER INFORMATION

These lessons were written with Grades 4 – 8 in mind. All student materials are written at a 6th grade reading level. The lessons in this unit are arranged sequentially, but individual lessons may be taught or deleted as best suits you and your class.

POSSIBLE IMPLEMENTATION OF LITTER UNIT

Monday	I. Introduction/Art Activity	30 min.
Tuesday	II. Survey	30 min.
	III. Predicting and Mapping	15 min.
Wednesday	IV. Outdoor Science	45 min.
	V. Math and Language Arts (Homework)	20 min.
Thursday	VI. Analyzing	15 min.
	Follow-up activity (Homework)	20 min.
Friday	VII. Reading and Decision Making (Homework)	20 min.
	VIII. Values Discussion and Writing	40 min.
Monday	IX. Group Problem Solving Activity	20 min.
Tuesday	X. Science Activity	30 min.

Lesson I

LITTER – WHAT'S THE PROBLEM?

Students will be able to define litter and name several sources of litter. Students will identify some of the problems resulting from careless disposal of waste.

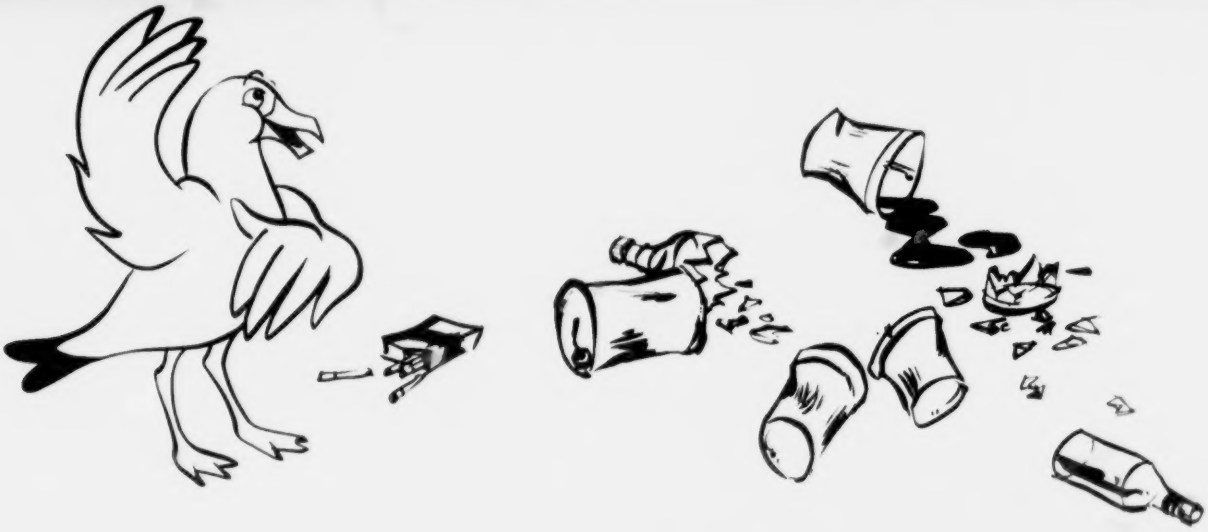
MATERIALS NEEDED
Student reading sheet (one per child)
Student worksheet (one per child)

IMPLEMENTATION
Distribute student worksheet and have students read the information. Discuss the problem of litter with students, encouraging them to identify its effect on them, personally. Help students to recognize that litter causes problems for everyone (cost, pollution, unsightliness, and health hazards).

Encourage students to hypothesize about why people litter. Some possible explanations you may wish to discuss:

- People tend to litter where there is already litter.
- Disposing of trash carelessly is normal behavior for some people (i.e., a habit).
- People tend to litter where they think someone will clean up after them.
- People tend to litter where they feel the property is someone else's concern.
- Some people ignore litter and simply don't see loose trash as an eyesore.

Distribute "Litter Hurts" worksheet for students to complete, independently, encouraging them to share their answers and ideas upon completion.



LITTER – WHAT'S THE PROBLEM?

Litter is waste material carelessly thrown away. But where does it come from? Illegal dumping, uncovered garbage trucks, home and business trash cans, loading docks, construction sites, and people like you and me, all produce litter. Many people think that the candy wrapper or cigarette they drop on the ground is not a problem; someone else will clean it up or it will magically disappear. But it costs a lot of money to clean up litter. The people who pick it up must be paid. They need supplies like rakes, shovels and bags. It is expensive to kill the rats and insects that live in the trash. Sometimes people are hurt by litter and have hospital and doctor bills to pay.

In our state, crews pick up *eight million* pieces of litter each year! More than half of this is paper from food packages, cups, fast food, and newspapers. Over 1 million metal cans and car parts, 1 million plastic bags and bottles, and 1 million glass bottles are left on our roads. Other things like building materials and food wastes are found near roads, at parks, and on beaches, too.

Litter doesn't just stay where it's dropped. Wind, water, cars and animals carry it from place to place. It is trapped against fences and the bottom of walls, in the gutters, along river banks and in vacant lots.

Litter is ugly and dangerous. We need to clean it up. We also need to change the behavior of people who litter.

LITTER HURTS!

How many dangerous situations caused by careless littering can you find in this picture? List them on a separate piece of paper.

Lesson II

TRASH STUDY
Survey

Students will conduct a survey to determine the litter habits of their peers.

MATERIALS NEEDED
About 100 pieces of an individually wrapped food (gum, candy, pretzels, etc.), a wastebasket full of trash, an attractively decorated litter basket and about five students to do the study

SOURCE
Adapted from OPERATION WASTE WATCH, Level 4

IMPLEMENTATION
Explain to students that they are going to conduct a survey in order to better understand the littering habits of their peers. You may wish to alert school authorities with regard to the survey, but the survey's accuracy depends on as few people as possible knowing that the survey is being conducted. People who know that they are being observed may not behave as they would normally.

Conduct the survey in the following manner: have one student stand by a door of the school where students will be leaving. This student will give a wrapped piece of food to each child as he leaves the school. Try to use a door where students will be walking in a fairly straight path. Place the attractive, empty litter basket 10 yards away from the door on the *right* side of the walk. Place a pile of trash 10 yards from the door on the *left* side of the path, opposite the litter basket. Position a student to watch the trash pile, one to watch the litter basket, one student to watch for children who take their wrappers with them and one to watch for children who throw their wrappers on the ground.

Advise students to give a piece of food to each of 100 students as they leave the building; give out the food one piece at a time. One "watcher" should record how many of the 100 children place their wrapper in the litter basket; one should record how many students put their wrappers on the trash pile. Another pupil should record the number of wrappers thrown on the ground, and another student should record how many wrappers were taken away from the area.

When the activity has been completed, have students pick up the trash pile as well as any other litter in the area. Collect the data from the "watchers" and place it on a chart. Discuss the information gathered, and assist students in drawing conclusions about the habits of their peers. Brainstorm some ideas on how to help children in your school litter less and use trash cans more.

EXTENSION
Students may wish to conduct an anti-litter campaign, educating other students and then repeat the experiment.

Lesson III

LITTER – IT'S EVERYWHERE!
Predicting and Mapping Activity

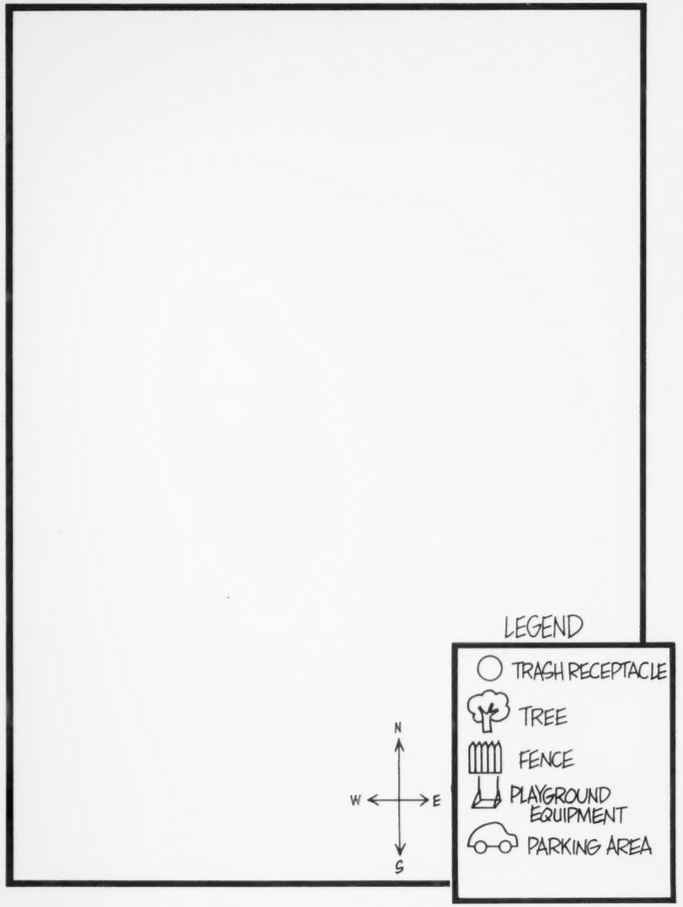
Students will predict the location of litter in the schoolyard and apply their predictions to a map.

MATERIALS NEEDED
Student worksheet (one per child)

BACKGROUND
School papers, food wastes from snacks, extra packaging and soda cans may all be found on the grounds of a schoolyard. Factors contributing to this problem may include: not enough trash cans in the schoolyard, careless students, the wind blowing trash against a fence, uncovered trash cans or neighborhood people using schoolyard facilities.

IMPLEMENTATION
Give each student a schoolyard map handout. Ask them to fill in the details of the schoolyard (fences, parking lots, trash cans, playground equipment, trees, surrounding streets, etc.). Tell students to circle on their maps the places where they predict that the most litter will be found. Encourage children to explain their choices.

Ask students to decide if they think litter is a problem in their schoolyard. Have them consider what types of litter they think would be found in the yard, and any possible reasons they have to explain this.



Lesson IV

TRASH TREASURE HUNT
Outdoor Science Activity

Students will observe litter, both natural and manmade, in the schoolyard. By gathering and discussing, they will come to understand the variety and sources of litter.

MATERIALS NEEDED
"Scavenger Hunt List" (one per child or group), paper bags

SOURCE
THE RECYCLUM

IMPLEMENTATION
Explain to students that they are going on a trash treasure hunt to explore and document the litter problem in their schoolyard and neighborhood.

Students may work individually or in small groups. Distribute the "Scavenger Hunt List," and encourage students to speculate on possible answers prior to actual schoolyard exploration. Tell them that they will have to think carefully to determine what types of litter fall into each category. Explain that bringing back a description of a natural item is preferable to disturbing some items which should remain untouched.

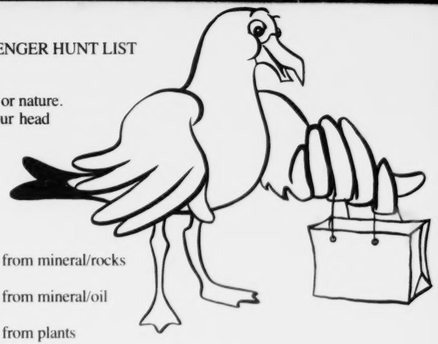
Take students on a walk around the schoolgrounds, neighborhood or a nearby park, wherever it is safe and convenient. Encourage students to observe manmade litter wherever it occurs, and to be prepared to discuss its location upon returning to the classroom. Then send students off in different directions to collect items for the Treasure Hunt. Set a time limit for this segment of the activity.

Return to the classroom and have students discuss and compare the items which they collected. Encourage students to determine what will eventually happen to manmade litter, and what will become of natural litter. Have students hypothesize about why people didn't carry their waste with them until they could dispose of it properly.

VOCABULARY
natural
manmade
biodegradable

EXTENSION
Students may write about the problem of litter, discussing when, where, and most importantly, WHY people do litter.

SCAVENGER HUNT LIST



Bring back only discards from man or nature.
You can bring back an answer in your head that can't be put in your bag.

1. a natural food covering
2. a man-made food covering
3. some man-made litter that came from mineral/rocks
4. some man-made litter that came from mineral/oil
5. some man-made litter that came from plants
6. something man-made that can cut your finger (be careful not to hurt yourself!)
7. something that is decomposing (decaying)
8. something that could be recycled
9. something that a worm might like to eat
10. something that's been there for 100 years
11. something you could use in making a toy
12. something that helps a plant to grow
13. something that could hurt an animal
14. something from the lowest link in any food chain
15. something that would mold
16. something that doesn't come from the earth
17. something hard, something soft, something smooth, something rough
18. look for a sign of water, air, or noise pollution

Lesson V

LITTER ON OUR HIGHWAYS
Math and Language Arts Activity

Students will interpret a graph concerning litter on our highways. Students will make inferences about the types and sources of highway litter. Students will complete anecdotal stories describing the fate of one litter item.

MATERIALS NEEDED
Overhead projector, drawing paper, writing paper, crayons and magic markers

IMPLEMENTATION
Display the transparency concerning "Litter on our Highways." Focus students' attention by asking the following questions, with students writing answers on individual papers.

1. What percent of highway litter is made up of plastic? (10%)
2. What percent of highway litter is made up of paper? (60%)
3. What percent of highway litter is made up of metal and "other materials"? (15% + 10% = 25%)
4. If we could collect and recycle all glass and paper, how much could we reduce highway litter? (5% + 60% = 65%)
5. What specific items of metal might be found on the highway? (car parts, broken appliances, etc.)
6. What specific items of plastic might be found on the highway? (trash bags, children's toys, etc.)
7. What specific paper items might be found? (newspapers, packaging, fast food wrappers, etc.)
8. What specific glass things might be littered on the highway? (bottles from assorted beverages)
9. What other materials can you imagine might be littered on the highway? (tires, garbage, etc.)
10. Using the information on this graph, draw it as a circle graph.
11. How can we eliminate litter on the highways?

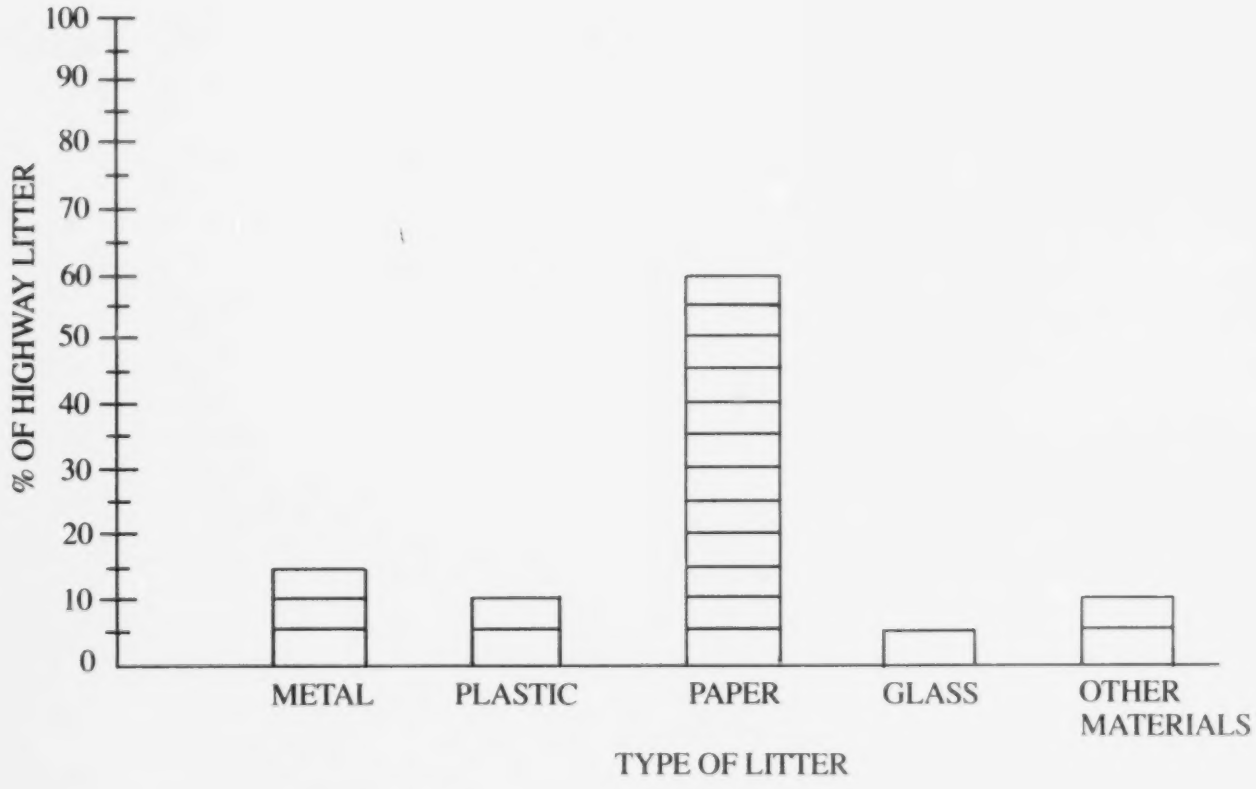
Read aloud the story, "Travels with an Aluminum Can". Encourage children to contemplate the life and fate of one of the items they named above. Distribute writing paper and help them to identify eight sequential scenes which could occur in the life of one particular piece of litter. Have students write out eight sentences or short paragraphs describing the scenes, then copy them in order onto a piece of drawing paper folded into eight boxes. Complete with illustrations and share with a younger audience to reinforce the concept of litter as misplaced waste, and a habit which can be broken.

EXTENSION
Distribute "Enduring Litter" and have students determine how long the items will last by calculating the future dates suggested by the information. For example, plastic six pack cover = today's date + 450 years.

LITTER ON OUR HIGHWAYS

GRAPH

The following graph shows the different types of litter found on our highways. Answer each question using the information given on the graph.



Travels with an Aluminum Can

A soda can is thrown from a car window. It lands on the road. After bouncing three times, it gets hit by six cars. Then it rolls into the gutter. This is not a very elegant home, but the can finds it safer than the road. He certainly has plenty of company. Ten minutes later, he is joined by a hamburger box and an empty bag that once held charcoal. Soon a potato chip wrapper and a donut shop coffee cup drop in.

Three days go by, and it starts to rain. Little puddles form on the ground. As the rain continues, the puddles grow larger. Some of the water overflows from the puddles and heads for the gutter. Up and down the street, all the puddles run together. Suddenly, the gutter, once so pleasant to the can, becomes a raging wall of water. The force is very strong. First it lifts the can's lighter buddies, the cup and the hamburger box. Before long, he, too, is floating along. "Where did all these cigarette butts come from?" he thinks. "They must have drifted in from some other neighborhood."

The can hears the sound of a waterfall roaring down into a black hole. He's afraid of the dark, so he tries to hold onto the grate covering the hole, but the current is too strong. With a roar, the can and his friends are swept into the hole. They are swept along on a dark swift current. "What is this place?" wonders the can. "Am I in an underground river? Why does it smell so awful down here? Oh no! I'm in a sewer! That's human waste I smell!"

Then he sees his old friend, the charcoal bag. Boy, is he in a fix! He is stuck in a small pipe leading to the sewage treatment plant. His body blocks the pipe completely. So the awful ride continues. The can smells fresh air mixed with the sewage odors. He hears cars rolling by and the cry of a seagull. He is swept along with the rest of the trash and human waste. SWOOSH . . . into a shallow river, bumping and clanking over slimy rocks.

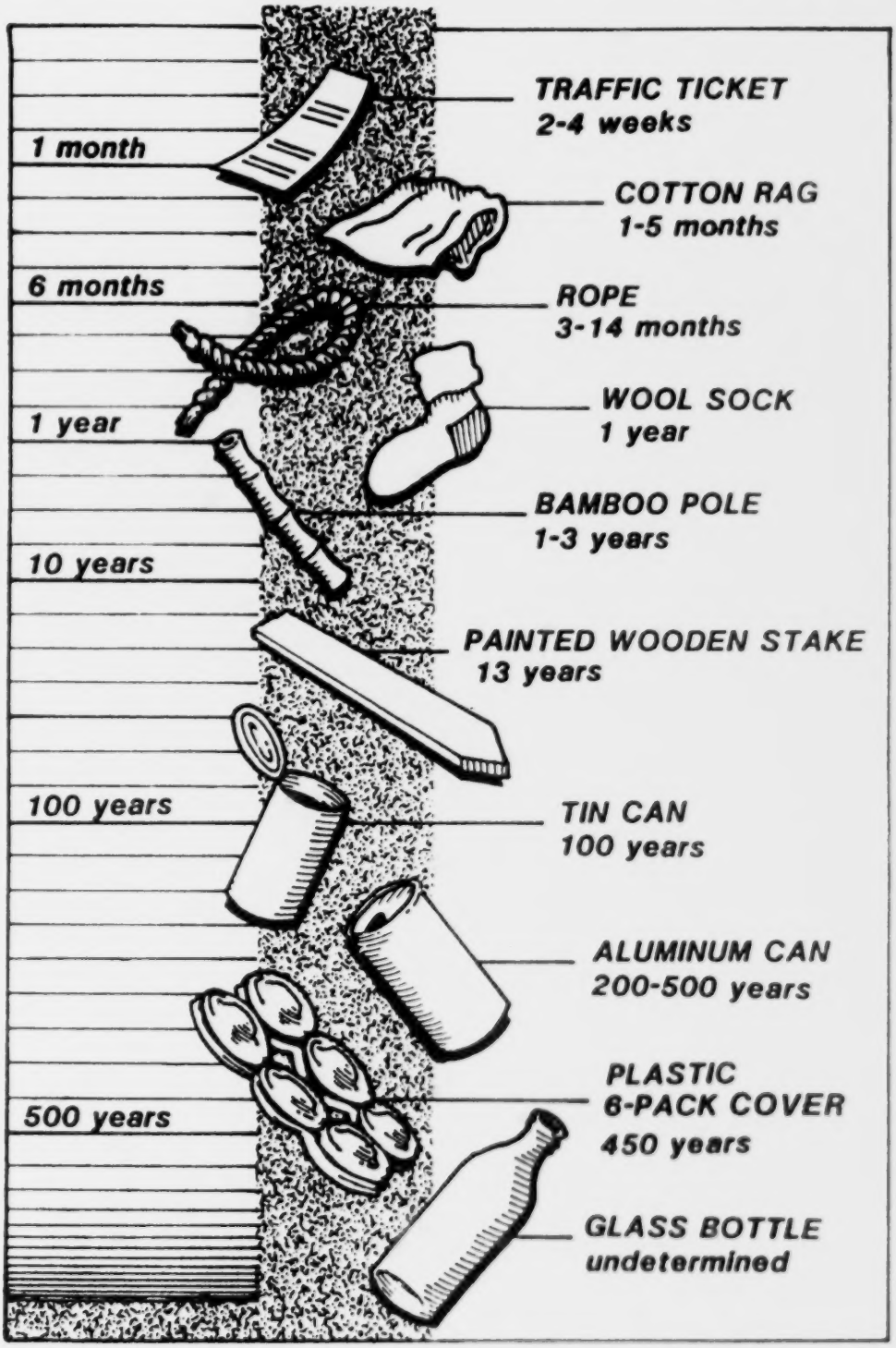
The can and his friends drift out into the Moshassuck River. Their journey stops at the Hurricane Barrier. When the tide switches direction, they are washed back up the river. After a few hours, the can floats down, again, as the tide reverses.

Thirty days go by. The can's trip comes to an end. After surviving fishermen's nets, sea gulls, and collisions with ships, he washes up on a beach in South County. "People leave this beach so dirty," he hears a lady say. She picks him up and puts him in her car. She seems to be the lady of his dreams. Will he finally be sent to a recycling center to be made into a new can? Surely she'll make his dream come true!

Three days later, a man gets into the same car. "My wife thinks this car is a trash barrel," he complains. He picks up the can. Further down the road, the bashed and battered can is thrown from the car window.

Enduring Litter

Litter at the roadside is ugly. How long it will stay before decaying may be an ugly surprise.



The Book of Lists, 2.

Lesson VI

THE PACKAGING PROBLEM
Analyzing Activity

Students will identify the problems associated with excess packaging.

MATERIALS NEEDED
One packaged snack per child (gum, crackers, juice box, etc.),"After Dinner" worksheet (one per child)

SOURCE
DON'T WASTE WASTE

BACKGROUND
In the past, packages were refillable and reuseable – thick glass bottles and cotton flour sacks. Today, our society manufactures approximately 660 pounds of packaging per person each year, and 600 pounds of that packaging then becomes solid waste. Packages *are* necessary, but companies design packages to be appealing and to sell the product, not to protect the environment.

IMPLEMENTATION
Distribute a packaged snack to the students – something that can be consumed leaving waste behind. Ask students to examine their snack and discuss the purposes of its packaging (to keep product clean, separate portions, make product attractive, make product safe for the consumer, prevent theft by increasing product size, etc.). Be sure to display any boxes and/or bags in which the product came from the market.

Allow students to consume the snack, leaving the package. Ask students to consider what problems this package might cause now (solid waste/garbage/trash may become litter, attract bugs and rodents, cause odor problems).

Deposit packaging in the waste basket. Ask if the package has stopped being a problem. Explain that it has simply become someone else's problem as it continues its route toward disposal.

Distribute the "After Dinner" worksheet. Students are asked to list the various containers and packages used to provide the described meal. Allow fifteen minutes or so to complete the worksheet. List responses on the blackboard and discuss the lists.

EXTENSION
Conduct a contest to design or identify the simplest possible package for a given product – one that will use up the fewest resources and leave behind the smallest amount of solid waste (the ice cream cone is one).

Challenge students to identify the five best packages (i.e., ones that can be used over and over again).

Design a simple but appealing package for a real or imaginary product of your choice. Write an advertisement and sell your product to the class.

NAME _____

AFTER DINNER – MORE THAN LEFTOVERS!

Imagine that you have to cook dinner for your family tonight. List every package or container you'll need to open in order to prepare the following menu:

CHICKEN NOODLE SOUP

TOSSED SALAD WITH DRESSING

HAMBURGER

ICE CREAM

ROLL OR BUN

COOKIES

KETCHUP

MILK

PICKLES

Think about it: what natural resources were consumed to make all these packages?

Teacher's Page

AFTER DINNER – MORE THAN LEFTOVERS!

Imagine that you have to cook dinner for your family tonight. List every package or container you'll need to open in order to prepare the following menu:

CHICKEN NOODLE SOUP
- can or box with foil envelope inside

HAMBURGER
- styrofoam
- cellophane wrap

ROLL OR BUN
- plastic bag

KETCHUP
- glass bottle or plastic squeeze jar

PICKLES
- glass bottle with metal lid

TOSSED SALAD WITH DRESSING
- cellophane lettuce wrapper, plastic bags for vegetables, glass bottle with plastic top

ICE CREAM
- cardboard box

COOKIES
- cardboard box with waxed paper or foil liner or cellophane

MILK
- plastic jug or waxed cardboard

Think about it: what natural resources were consumed to make all these packages?
- metal, tree, petroleum, silica, fossil fuels used as energy for production

Lesson VII

PACKAGING: HOW MUCH IS TOO MUCH?
Reading and Decision Making Activity

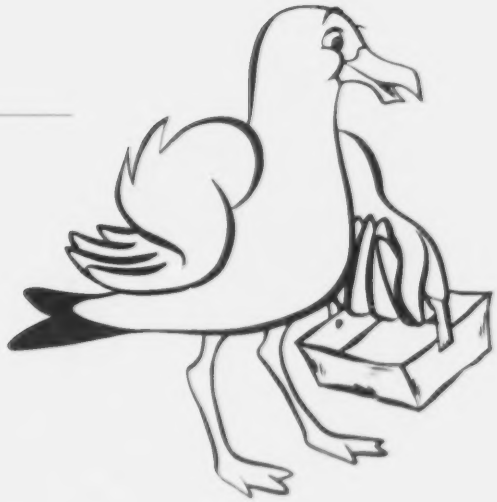
Students will read about packaging in an historical context and make choices concerning packaging options.

MATERIALS NEEDED
Student worksheets (one per child)

IMPLEMENTATION
Distribute reading sheet to students. Help them to focus their reading by asking them to sum up the main idea of the article in a title phrase. List title selections on the board, discuss, and choose one that best summarizes the point of the article.

Distribute "You Do Have a Choice", advising students to make careful consumer choices, based on what they have learned about packaging. Help them relate the concept of over-packaging to the problems of litter and solid waste disposal.

NAME _____



TITLE _____

The first Americans made full use of the resources they had. They could not afford to be wasteful. There were no supermarkets and no hardware stores to meet their needs. That is why when an Indian killed a buffalo, he used every available part. The meat was eaten, the hide made into clothing and blankets and the bone and hooves became weapons and tools.

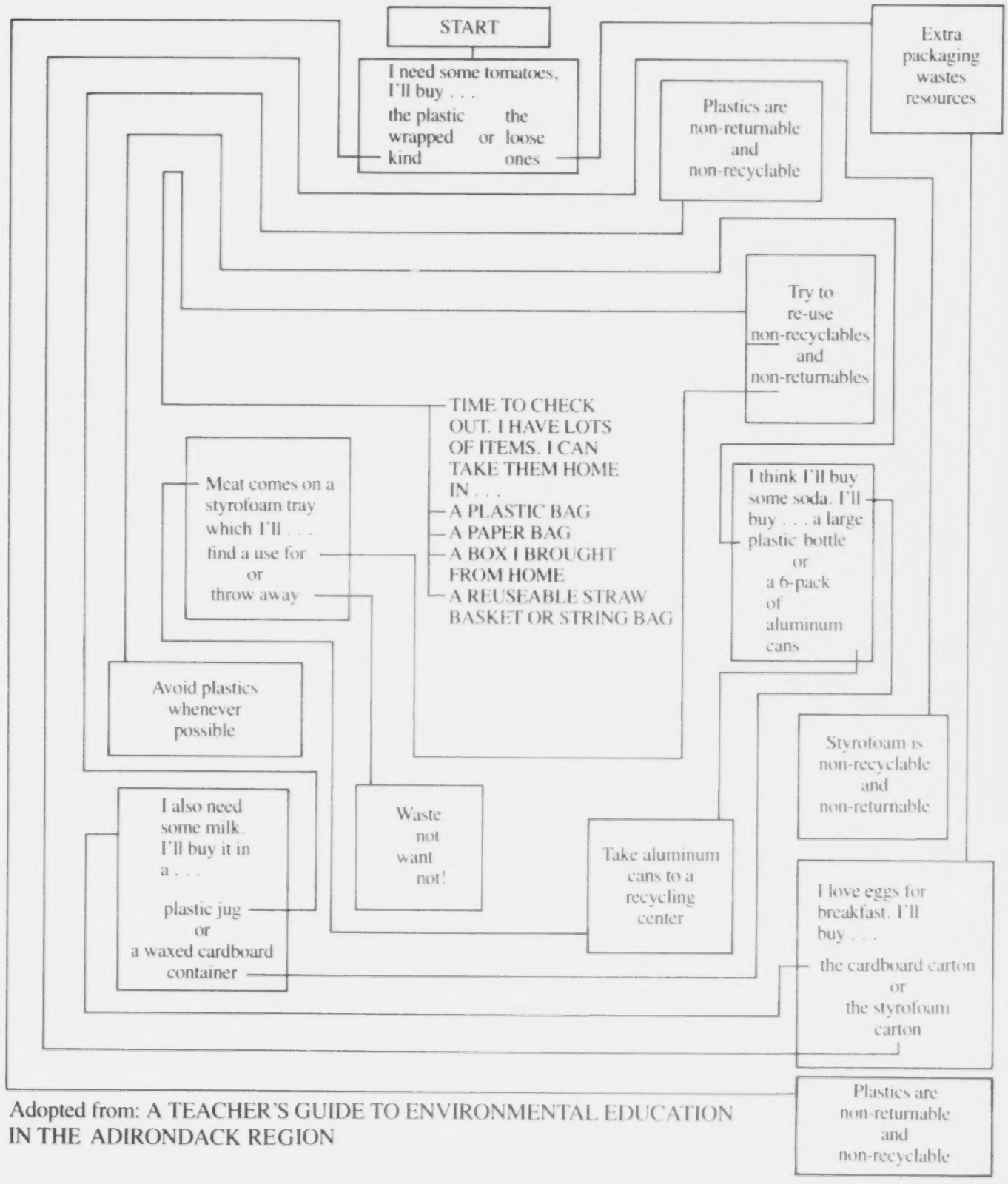
Later settlers from the eastern United States could not waste anything either. It was too hard to get replacements. So clothes were handed down from one child to another. When they became too ragged, they were pieced into quilts. Worn out quilts were pieced into new ones. Only when every possible use had been exhausted could an item be thrown out.

In those days, few items came in disposable packages. Flour came in cotton sacks which were reused to make underwear. When a pioneer woman shopped at a general store, she brought a straw basket with her. The store did not supply her with bags.

Today, many items are designed to be used once or twice and then thrown away. We may find it easier to replace something rather than to repair it or find a new use for it. Almost everything we buy comes in a package, which ends up in the trash. Packaging claims eight percent of our food dollars. Non-renewable resources, such as metals and oil,are used in packaging. We also throw away large amounts of paper and glass which our ancestors would have reused.

It is important to conserve our natural resources. So,we should be careful about what we buy and what we discard. What choices do you have as a consumer? Plenty!

YOU *DO* HAVE A CHOICE!


START
I need some tomatoes. I'll buy . . .
the plastic wrapped kind
or
the loose ones
Extra packaging wastes resources
Plastics are non-returnable and non-recyclable
Try to re-use non-recyclables and non-returnables
TIME TO CHECK OUT. I HAVE LOTS OF ITEMS. I CAN TAKE THEM HOME IN . . .
A PLASTIC BAG
A PAPER BAG
A BOX I BROUGHT FROM HOME
A REUSEABLE STRAW BASKET OR STRING BAG
Meat comes on a styrofoam tray which I'll . . .
find a use for
or
throw away
I think I'll buy some soda. I'll buy . . . a large plastic bottle
or
a 6-pack of aluminum cans
Avoid plastics whenever possible
Styrofoam is non-recyclable and non-returnable
I also need some milk. I'll buy it in a . . .
plastic jug
or
a waxed cardboard container
Waste not want not!
Take aluminum cans to a recycling center
I love eggs for breakfast. I'll buy . . .
the cardboard carton
or
the styrofoam carton
Plastics are non-returnable and non-recyclable

Adopted from: A TEACHER'S GUIDE TO ENVIRONMENTAL EDUCATION IN THE ADIRONDACK REGION

Lesson VIII

LITTERING – IT'S AGAINST THE LAW!
Values Discussion and Writing Activity

Students will discuss the rationale for rules/laws in our society. Students will examine the Rhode Island Litter Law and analyze its effectiveness.

MATERIALS NEEDED
Overhead projector, writing paper

IMPLEMENTATION
Guide students to an understanding of the need for rules or laws in our society, through the following discussion questions:

1. What is a rule? (a guide for conduct or action, regulation or law, accepted procedure)

2. Why do we have rules? (People have to live together but don't all have the same value systems. We need rules to help us work together and maintain order.)

3. What do rules do? (limit or restrict behavior, provide protection against others' inappropriate behavior)

4. What happens at home or school when someone breaks the rules? (punishment – usually in proportion to the seriousness of the problem: sent to room, spanked, loss of privileges, etc.)

5. What is a law? (A rule of conduct formally recognized and enforced by a controlling authority.)

6. What happens when someone breaks the law? (punishment, via fines and/or jail)

Place the Rhode Island Litter Law on the overhead projector, to allow students to read it in detail. Assist younger readers with any difficult language.

Ask students to consider:

1. How do we know that people do not obey the litter law?

2. Why do you think these laws are not obeyed?

3. If more stringent anti-litter laws were passed, would people be likely to obey them all the time?

4. Is litter so harmful or ugly that the expense of cleaning it up is worthwhile?

5. Is the only way of solving the litter problem to pay higher taxes for more cleanups or are there other solutions?

Distribute writing paper and urge students to discuss the following issue: how do you think the litter law could be changed to make it more effective? Encourage children to share their ideas, orally, weighing all suggestions for feasibility and possible effectiveness.

EXTENSION
As a class or individual, write a letter to the Mayor, City Council and/or Police Chief of your town. Tell them about the results of your Trash Treasure Hunt. Ask how you could help improve the enforcement of litter laws in your community or offer your own suggestions.

Write an article for the local newspaper describing the results of your efforts and asking for community assistance to clean up the area.

RHODE ISLAND LITTER LAW

37-15-6. LITTERING PROHIBITED – No person shall throw, drop, deposit , discard, or otherwise dispose of litter upon any public property in the state or in the waters of this state or upon private property in this state owned by him except:

(1) When such property is designated by the state or by any of its agencies or political subdivisions for the disposal of solid waste or litter, and such person is authorized to use such property for such purpose; or

(2) Into a litter receptacle in such a manner that the litter will be prevented from being carried away by the elements.

37-15-7. PENALTIES – (A) Any person convicted of a first violation of this chapter shall, except where a penalty is specifically set forth, be subject to a fine of not less than fifteen dollars ($15.00) not more than one hundred dollars ($100.00). In addition to or in lieu of the fine imposed hereunder, the person so convicted may be ordered to pick up litter for not less than two (2) nor more than twenty-five (25) hours.

Lesson IX

LITTER AND ANIMALS
Group Problem Solving

Students will identify ways that litter can adversely affect wildlife and devise potential solutions to real life situations.

MATERIALS NEEDED
Litter Cards

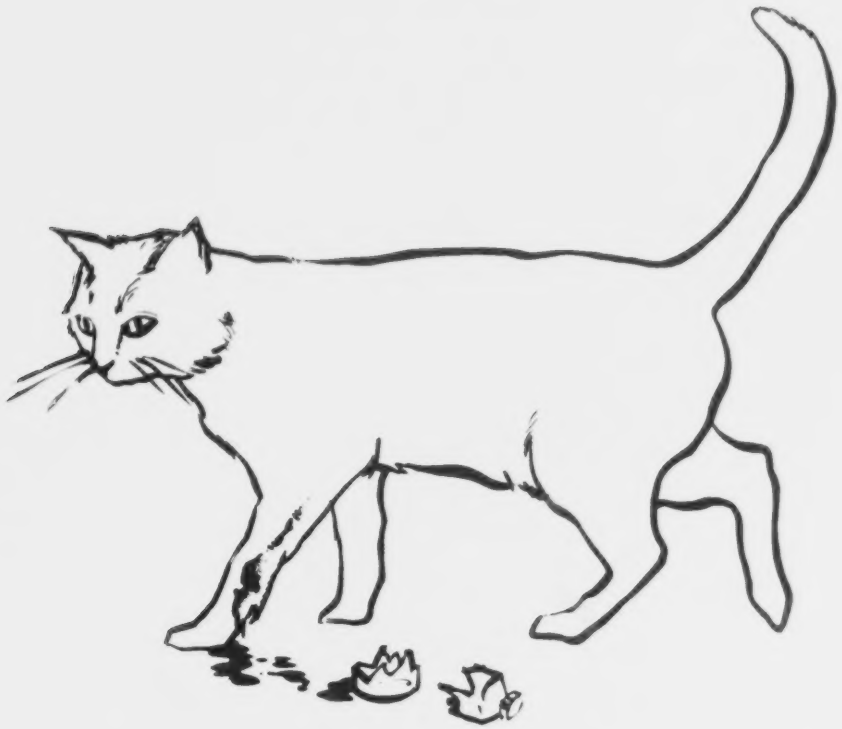
BACKGROUND
Human beings share the earth with a wide variety of animals. Unfortunately, we share our pollution with them, as well. In addition to ugliness, litter can also be life threatening to both pets and wildlife.

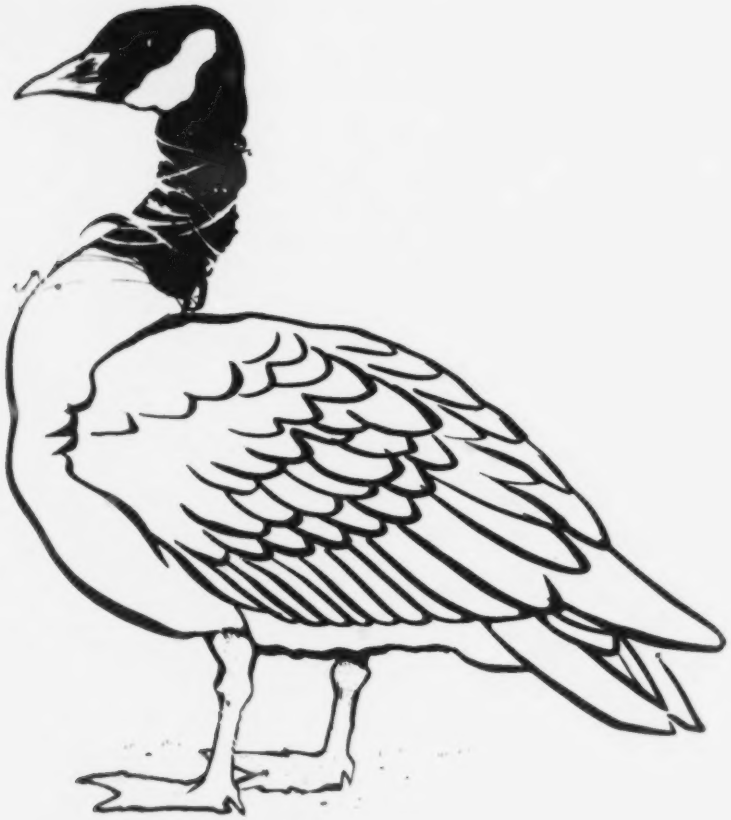
Specific problems include: 1) Fish or birds may become entangled in the plastic rings from a six pack of cans. If the loop encircles a young animal's neck, it will be unable to eat. 2) Loops also may twist around an animal's feet, preventing it from walking or flying. 3) Jagged cans may cut the mouths of larger animals like deer. 4) Smaller anim ds may get their heads stuck inside the cans as they attempt to lick the food contents. 5) Mice and chipmunks have been trapped in glass bottles, unable to get a solid footing to push themselves out. 6) Broken glass and sharp bottle caps littered in forests can cut delicate feet. 7) At sea, commercial fishing fleets annually lose or discard millions of pounds of plastic fishing gear, including nets, lines and buoys. Sea birds eat many of these plastic bits, which resemble the crustaceans they are fond of eating. Since clear plastic bags bear a strong resemblance to jelly-fish, they attract both birds and sea turtles. Once an animal eats these bags, its digestive tract is blocked and the animal dies. 8) Plastic fishing line can also wrap around the legs and wings of water birds like geese and heron, hindering their ability to swim. Since these birds must run a short distance before taking off in flight, the line may also keep them from flying. 9) Line wrapped around a bird's long bill may cause it to starve.

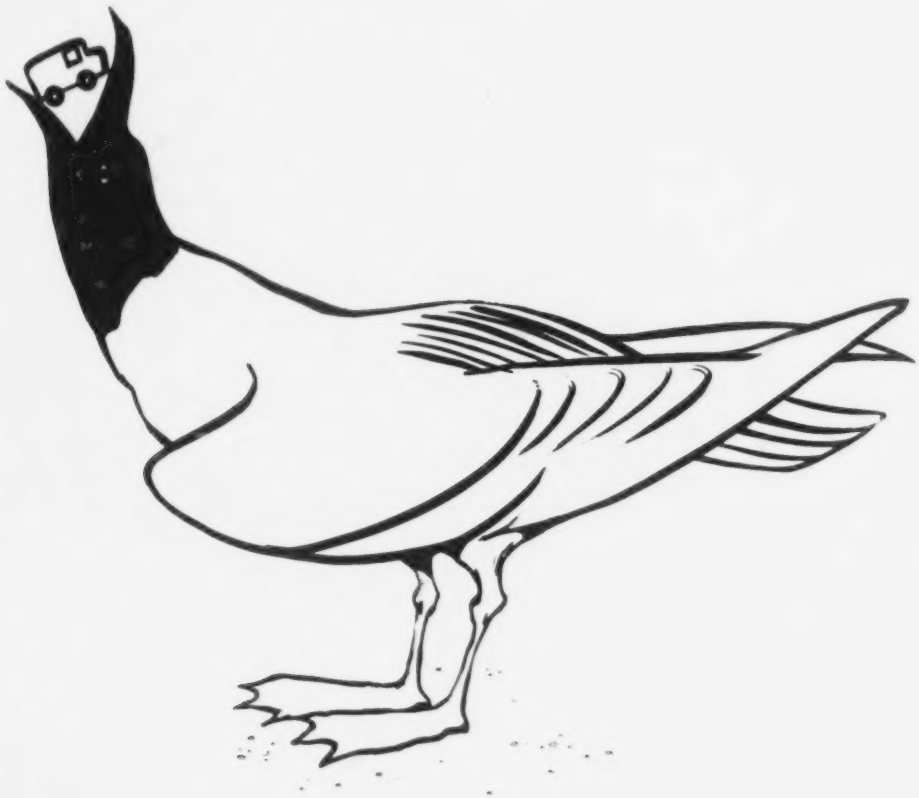
IMPLEMENTATION
Divide class into small groups. Give each group a " Litter and Animals " card. Each card features a situation in which litter has caused a problem for an animal. The cards are based on actual events which have been reported to DEM or appeared in the news. Ask the students to describe the problem, identify its potential consequences and explain how this problem could be avoided in the future. Urge each group to prepare a presentation of their problem and potential solutions to share with the class.

Example: A goose's neck is entangled in a piece of monofilament fishing line. Since the bird cannot free itself, it will most likely die of starvation or kill itself in a frantic effort to get free. If fishermen were more careful to dispose of their broken line in proper receptacles, birds would not be affected.

EXTENSION
Students may complete additional cards individually or in small groups. Challenge students to create their own drawing of animals endangered by different forms of litter.







Lesson X

OIL AND WILDLIFE
Science Activity

Students will conduct experiments to determine the effects of oil and detergents on forms of wildlife.

MATERIALS NEEDED
Used motor oil, salad oil, shallow containers, eye dropper, magnifying glass, feathers (natural), liquid detergent, hard-boiled eggs

SOURCE
PROJECT WILD

BACKGROUND
Used motor oil is often poured into storm drains and septic systems, onto open land and into streams, rivers and ponds. This toxic oil damages the environment: it pollutes recreational areas and waterways, it harms wildlife and it can seep into our groundwater – the water we use for drinking.

Oil can damage the feathers of birds; seep into eggs and destroy the embryos; suffocate fish by clogging their gills; and kill other marine and terrestrial animals which may drink contaminated water.

Detergents used to remove oil from the feathers of birds may also remove the natural oils which allow the birds' feathers to repel water. Thus, the birds are susceptible to drowning or to stress related illnesses. Obviously their food and water sources may also be adversely affected.

IMPLEMENTATION
To have children examine the effects of oil on eggs, conduct the following experiment:

Place motor oil in a container and add three hardboiled eggs. Remove the first egg after five minutes, the second after fifteen minutes and the third after thirty minutes, examining each by peeling off the shell. Discuss and record observations. Help children to draw conclusions as to what effect oil could have on the eggs of birds nesting near the water. Note: this experiment may also be conducted using raw eggs. Following the soaking in oil, crack the shell and examine its interior for brown spots, an indication of oil penetration.

To examine the effect of oil on adult birds, conduct the following experiment:

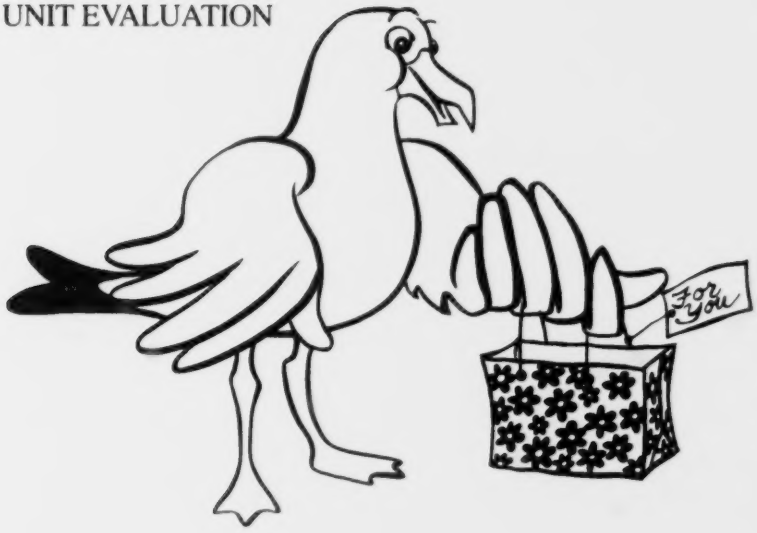
1) Have students examine a feather with the magnifying glass and draw what they see. Dip the feather in water for a few minutes. Instruct children to examine the feather again and draw what they now see. Encourage them to record their observations and compare the two drawings.

2) Next, place the feather in salad oil for one minute. Examine it with the magnifying glass, sketch and compare with the two previous drawings. Clean the feather with detergent, examine and sketch again. Encourage students to describe the changes in the feather after exposure to oil and to detergent. Repeat this step using motor oil. Lead students to compare the damage done by different types of oil.

3) Draw conclusions about the effect exposure to oil and detergents might have on normal bird activity.

NOTE: if possible, one feather per child will allow for the fullest participation of the group members.

LITTER – UNIT EVALUATION



Think about what you have learned in this unit. Litter comes in many forms, like paper, glass, and plastic. It can hurt people and animals, and it's ugly to look at. People cause litter by being careless.

Decorate a bag by showing two kinds of litter. Make it attractive so that people will look at it. Think of a slogan for your bag which might teach others about litter. Present the bag to a friend or relative. Tell them what you have learned about our litter problem. Encourage them to use the litter bag.

LITTER
VOCABULARY

biodegradable – able to be broken down by microorganisms into simple, stable compounds

compact – to press together, compress

compost – a mixture of decayed organic matter used for fertilizer or soil conditioner

decompose – to separate or break down into organic components or elements

dispose of – to get rid of, transfer to the control of another

dumpster – a metal container where discarded materials are stored before disposal

ground water – water from beneath the earth's surface, between saturated soil and rock, which supplies wells and springs

litter – waste materials carelessly discarded in an inappropriate place

organic waste – discarded materials that were derived from living organisms, for example, food or yard waste

recycling – collection and processing of materials for reuse either in the same form or as part of a different product

resource – valuable material, source of wealth

solid waste – all items discarded after use, in a solid state, that must be collected and disposed of, including garbage, rubbish, ashes and industrial wastes; does *not* include sewage, smoke or gases

Don't Waste Waste. New York, NY: Environmental Action Coalition.

Operation Waste Watch. Richmond, VA: Virginia Division of Litter Control, Department of Conservation and Economic Development, 1215 State Office Building, 1979.

Project Wild. Western Regional Environmental Education Council, 1985.

The Recyclum: A Resource Conservation Curriculum for Grades K-6. Eco-Alliance, Inc., 1981.

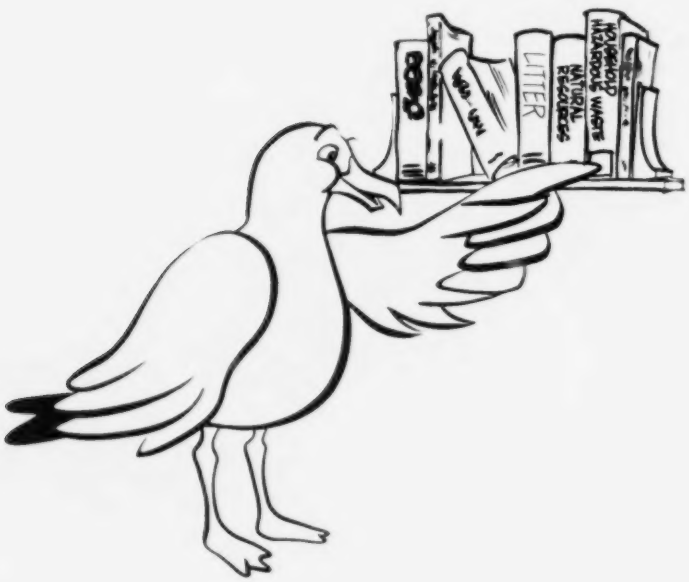
A Teacher's Guide to Environmental Education in the Adirondack Region. Albany, NY: New York State Department of Environmental Conservation, 1981.

Wallace, Irving, et al. *The Book of Lists, 2*. New York: William Morrow and Co., 1980.

OSCAR'S OPTIONS

UNIT III

HOUSEHOLD HAZARDOUS WASTE



When astronauts first landed on the moon, scientists on earth worried that substances brought back with the returning space travelers would be harmful to us. An organism foreign to the earth might be toxic. Man might have no natural "resistance" to its effects. A foreign organism might grow well in the earth's atmosphere and lead to a serious epidemic. These very real fears dictated that the astronauts and all moon materials be quarantined until scientists were convinced that our lives were not threatened.

Yet, in the last twenty years, over six million new chemicals not occurring in nature were introduced to this planet. The EPA (Environmental Protection Agency) estimates that more than 80,000 chemicals are used industrially in the U.S., and a majority are synthetic chemicals. Just like the moon rocks, we cannot predict the consequences of the use of any of these.

In an effort to protect us and to control some of these chemicals, laws were passed: the Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), and the Hazardous Substances Act (HSA) are among those laws. Under TSCA, selected chemicals are tested by the manufacturer. Results are submitted to the government which then decides whether the substance should be banned, regulated or left unregulated. All chemical substances predating these laws were "grandfathered" – allowed to remain in use without testing until sufficient problems were documented against them. The testing system itself is riddled with problems: the number of chemicals overwhelms both testing capacity and regulatory process. *Sierra* magazine (October, 1985) claims that "2-4 years and $40,000 to $ 1 million are required to test each chemical. Only 18% of all food additives, 10% of all pesticides and 1% of all commercial chemicals have been carefully tested." While different authorities might be more generous in the percentages given, no one maintains that the products we use are guaranteed by anyone to be safe.

The HSA establishes labeling requirements for consumer products containing hazardous substances. The law empowers the Consumer Product Safety Commission to ban substances posing such an extreme hazard that adequate labeling cannot be written, and governs such protective packaging as child-proof containers. Under this law, a hazardous substance is one which is toxic, corrosive, an irritant, flammable or combustible, a strong sensitizer, generates pressure, is radioactive or can cause substantial personal injury or illness.

Pesticides – chemicals used to kill insects, weeds, rodents, fungus and germs are governed by FIFRA. Farmers are required by law to have a license to spray pesticides, and therefore they are given special information on their use and disposal. Consumers have to rely upon the label to tell them about special uses and precautions. Some insecticides, for example, must not be sprayed directly upon fruit that will be harvested, while others are so corrosive that you must protect equipment from exposure to them to protect the paint on the equipment. Some pesticides used in agriculture are so long-lived that no one can enter the field for weeks after they have been applied. While farmers are required to get a permit before using certain pesticides, consumers are able to buy that same pesticide right off the shelf. Most homeowners are unaware of the conditions attached to commercial applications of some pesticides. In addition to causing health problems, some products can do other damage when used improperly, including when used to excess. Manufacturers have established the legal right to say that any problem resulting from use of their products that is not in exact compliance with instructions on the label is not their responsibility.

Residential toxic waste is unregulated. There is at present no control over its entry into the environment. Labels on household cleaning agents, automotive products, paint products and pesticides are insufficient, at present, to allow consumers to make informed disposal (or purchase) choices. Any product whose label contains the words "danger", "poison", "flammable", "caution", "warning", "acid" or "pesticide", can be presumed to contain a potentially hazardous material. Many chemicals regulated within industry under TSCA or FIFRA are unregulated for household use or disposal. The theory is that household amounts are so small that their environmental effects would be minimal. Yet, 945,000 Rhode Island residents can create a tremendous amount of household hazardous waste. As liquids leach out from the Central Landfill and threaten groundwater supplies, or hazardous substances pass untreated through sewage treatment plants on their way to Narragansett Bay, the problem becomes more and more severe. Until laws are made more stringent, educating the populace of the state is the only way we have to protect ourselves from careless contamination of our natural resources.

This curriculum's intent is not to frighten the students/consumers, but to caution them. There are health and environmental risks associated even with proper use of many common household products. Hopefully, an awareness of those risks will lead to either greater self-protection by the user or wiser consumer choices.

HOUSEHOLD HAZAROUS WASTE

OBJECTIVES

1. Students will identify common products which may be hazardous when used, predict consequences of careless usage, and devise ways to safeguard against accidental poisoning by toxic substances.

2. Students will identify health hazards commonly associated with some chemicals used in household products and debate the issue of more stringent labeling for consumer protection.

3. Students will apply mathematical processes to figures concerning consumption of cleaning materials to gain an understanding of the magnitude of the problem.

4. Students will listen to a story concerning environmental effects of pesticides and display their comprehension by completing reading worksheet.

5. Students will become familiar with common disposal practices and apply group problem solving techniques to situations pertinent to disposal of household hazardous waste.

6. Students will apply mathematical processes to manipulate data pertinent to DEM'S Toxic Cleanup Days.

7. Students will be able to name two hazardous household substances and discuss methods of recycling them.

8. Students will become familiar with less toxic substances which can be used in place of common home and garden products.

9. Students will learn about alternative, non-toxic solutions to combating common home and garden pests.

10. Students will analyze both sides of the issues raised within this unit, take a stand, and defend their position.

ACTIVITIES

I.	HOME SAFE HOME	Reading/Art
II.	IS CLEANING HAZARDOUS TO YOUR HEALTH?	Dictionary/Science
III.	MR. CLEAN STRIKES AGAIN	Math
IV.	WHO KILLED COCK ROBIN?	Reading/Comprehension
V.	WHERE DOES IT GO?	Reading/Problem Solving
VI.	SOLVE IT!	Math
VII.	USE IT UP OR USE IT OVER	Science
VIII.	TOXIC FREE BINGO	Science
IX.	FIGHTING PESTS WITH PESTS	Language Arts/Art/Science/Research
X.	THINK ABOUT IT	Language Arts/Problem Solving

TEACHER INFORMATION

These lessons were written with Grades 4 – 8 in mind. All student materials are written at a 6th grade reading level, except for *Cock Robin* and *Fighting Pests with Pests* which are both at a 4th grade level. The lessons are arranged sequentially, but individual lessons may be taught or deleted as best suits you and your class.

HOUSEHOLD HAZARDOUS WASTE – POSSIBLE UNIT OUTLINE

Monday	I.	Introduction/Reading & Art	40 minutes
	II.	Dictionary/Science Sheet (Homework)	30 minutes
Tuesday	III.	Math Problem Solving (Homework)	30 minutes
	IV.	Reading	30 minutes
Wednesday	V.	Reading & Problem Solving	40 minutes
	VI.	Math Problem Solving (Homework)	20 minutes
Thursday	VII.	Science	40 minutes
Friday	VIII.	Science Game	20 minutes
Monday	IX.	Language Arts/Art/Science/Research	45 minutes
	X.	Language Arts/Problem Solving (Homework)	30 minutes
Tuesday	X.	Discussion	

Lesson I

HOME SAFE HOME
Reading/Art Activity

Students will identify common household products which may be hazardous when used, predict consequences of careless usage, and devise ways to safeguard against accidental poisoning by toxic substances.

MATERIALS NEEDED
Student reading sheet, drawing paper, drawing materials

IMPLEMENTATION
1. Distribute reading sheet and discuss. Utilize " Unsafe Situations " Sheet in one of the following ways, sharing information found on teacher answer sheet:

a) Distribute copies of " Unsafe Situations " to students and have them complete predictions in writing. Discuss both their predictions and methods for rectifying the unsafe aspects.

b) Read aloud " Unsafe Situations " and have students brainstorm both problems and solutions.

c) Allow teams of students to act out a scenario, then encourage classmates to brainstorm ways to avoid such danger.

2. Distribute drawing materials. Instruct students to draw a diagram of their homes and label (by location) 20 items commonly found in their homes which they believe may be toxic.

The list may include: nail polish remover, furniture stripper, flea powder, spot remover, kerosene, flea collars, toilet bowl cleaners, laundry detergent, weed killers, oil, antifreeze, brake fluid, paint, room deodorizers, oven cleaners, glass and window cleaners, furniture polish, paint stripper, medicine, pool acids, bubble bath, floor polish, roach spray, paint thinner, photographic chemicals, turpentine, wood preservatives, rat poison, no-pest strips, mothballs, disinfectant cleaners, bleach, scouring powder, drain openers, stains and varnishes, charcoal lighter.

Upon completion, share results and discuss. Assist children in identifying ways to lessen the chances of accidental poisoning (storing materials in original containers, keeping toxic materials on high shelf or in locked cabinets, child proof caps, etc.). Discuss the Poison Control Center and its purpose.

VOCABULARY

toxic	potential	poison	ingestion
inhalation	absorption	acute	chronic

EXTENSION
Have older students survey their homes to see how many toxic items are actually used by their families. Graph results.

Share enclosed newspaper article with students. Have them collect similar articles concerning toxic substances and human health for classroom display.

Prolonged or excessive use of high concentration insect repellents should be avoided because it can cause allergic and toxic reactions, "The Medical Letter" reports.

The most effective insect repellent applied to the skin is a chemical commonly known as "deet". It is effective against mosquitoes, chiggers, ticks, fleas and biting flies.

But medical journals report a growing number of serious human reactions to deet, which is absorbed through the skin. Even in low concentrations it can cause hives and skin rashes.

"The Medical Letter", a newsletter covering the pharmaceutical industry, cited two reports of more serious effects. A woman went into anaphylactic shock after touching someone who had just applied a 52 percent solution of deet repellent, and an 8-year-old girl developed a rash and altered behavior after a few days use of 15 percent deet and then had a grand mal seizure within hours of her first use of another repellent containing almost 100 percent deet.

Some widely available liquid repellents – including Jungle Pine, Muskol and Ben's 100 – contain 100 percent deet. In the early days of its use, before the 1970s, deet caused toxic and allergic reactions mainly after excessive or prolonged use by children. But with the growing availability of high-concentration repellents, warns the "Letter", brief exposure to smaller amounts has caused serious reactions in children and adults.

The newsletter's conclusion: repellents with lower concentrations of deet may have to be applied more often, but they may be safer."

HOME, SAFE HOME

You may think of your home as a safe place in which to play and live. But within your home there are many unsafe things. Toxic chemicals can be found in just about every room. Toxic means poisonous. Using such substances carelessly may result in injury, illness or death.

Where are these poisons and what are they doing in your house? They are found in cleaning compounds, pet products and home maintenance supplies. We use them to make our homes cleaner or to make our lives easier.

But they can be harmful to our health. Eating or drinking a toxic substance can be fatal. Even proper use of toxins can lead to real problems. Headaches, nausea, and lightheadedness are acute symptoms. They are immediate reactions to inhaling a toxic substance or getting too much on your skin. Chronic reactions take a long time to appear. Cancer and damage to liver, kidneys or the central nervous system can be the result of exposure to toxic substances.

UNSAFE SITUATIONS

PRODUCT	SITUATION	PREDICTION
DRAIN CLEANER	When doorbell rang,the bottle was left on the bathroom floor. A baby was playing nearby.	
LEMON FURNITURE OIL	When polishing some furniture, the cap was lost. Polish was then placed in a glass near the sink.	
PILLS	Medicine was left on nightstand to help remind the patient to take it.	
ANTIFREEZE	After changing the antifreeze in a car, someone threw it into a ditch in front of the house.	
AEROSOL AIR FRESHENERS/ DEODORIZERS	A cooking smell was unpleasant so air freshener was sprayed in the kitchen. The can was left sitting on the stove.	
CHLORINE BLEACH AND AMMONIA	The bathroom tile wouldn't come clean using a bleach cleanser, so the person cleaning mixed some ammonia with the cleanser to make it stronger.	
FURNITURE STRIPPER	Your neighbor decided to strip the paint off an old chair. He is working in his work-shop, and turns on the fan.	
HAIR SPRAY	Your sister sprayed her hair to keep the style in place. She left the can on the radia-tor in the bathroom.	
PESTICIDES	To kill ants in the kitchen, an insect spray was applied to the floor. People in the home are often barefoot.	
OVEN CLEANER	Although the product called for the use of rubber gloves, the housekeeper felt they were too clumsy and used the product without them.	

Teacher's Page

UNSAFE SITUATIONS

(Allow students to predict and brainstorm possible consequences. Share information with students through discussion)

PRODUCT	SITUATION	PREDICTION
DRAIN CLEANER	When doorbell rang,the bottle was left on the bathroom floor. A baby was playing nearby.	Child could drink it; product is corrosive to skin and eyes.
LEMON FURNITURE OIL	When polishing some furniture, the cap was lost. Polish was then placed in a glass near the sink.	Someone might drink it, thinking it was safe; color and scent make it attractive.
PILLS	Medicine was left on nightstand to help remind the patient to take it.	Children may assume it is candy and eat it.
ANTIFREEZE	After changing the antifreeze in a car, someone threw it into a ditch in front of the house.	Pets have died from drinking puddles of antifreeze; they are attracted by its sweet taste; environmentally damaging.
AEROSOL AIR FRESHENERS/ DEODORIZERS	A cooking smell was unpleasant so air freshener was sprayed in the kitchen. The can was left sitting on the stove.	Fumes may make residents sick, or adhere to food; can could explode due to heat.
CHLORINE BLEACH AND AMMONIA	The bathroom tile wouldn't come clean using a bleach cleanser, so the person cleaning mixed some ammonia with the cleanser to make it stronger.	Mixing chlorine bleach and ammonia releases a toxic gas; the fumes can result in eye, throat, nose irritations and breathing difficulty; products should never be mixed.
FURNITURE STRIPPER	Your neighbor decided to strip the paint off an old chair. He's working in his workshop, and turns on the fan.	Using a fan in closed quarters will only recirculate the bad air; such products need extreme caution and plenty of fresh air.
HAIR SPRAY	Your sister sprayed her hair to keep the style in place. She left the can on the radiator in the bathroom.	Fumes from chemical sprays can irritate and damage skin, eyes and lungs; they can also cause internal harm by entering bloodstream through the lungs; containers can explode from heat.
PESTICIDES	To kill ants in the kitchen, an insect spray was applied to the floor. People in the home are often barefoot.	Chemicals can penetrate socks and be absorbed through the skin; health effects of pesticides, especially long-term effects, are not fully known.
OVEN CLEANER	Although the product called for the use of rubber gloves, the housekeeper felt they were too clumsy and used the product without them.	The chemicals could cause the skin to burn or develop a rash; skin and eye contact should be avoided.

Lesson II

IS CLEANING HAZARDOUS TO YOUR HEALTH?
Reading/Science Activity

Students will identify health hazards commonly associated with some chemicals used in household products and debate the issue of more stringent labeling for consumer protection.

MATERIALS NEEDED
"Warning!" worksheet, "Dictionary", chart (one each, per student or group)

SOURCE
Adapted from TOXICS IN MY HOME? YOU BET!

BACKGROUND
Since 1979, the EPA (Environmental Protection Agency) has required the testing of chemicals which will be used in commercial products. Chemicals in use prior to 1979 were given blanket (untested) approval. Until health hazards are documented against a certain chemical, it is presumed safe. If adverse health effects are suspected, the product remains on the market until the EPA completes additional testing. Testing may result in a product being banned (such as DDT), usage restricted (carbon tetrachloride, associated with liver damage, is now available only to professional cleaners) or more stringent labeling may be required.

Tests are most commonly performed on rats, monkeys, rabbits, and pigs. While animals can give us an indication of a chemical's safety, the reaction is not always applicable to humans. For instance, rats cannot vomit or miscarry and they manufacture Vitamin C within their own bodies, to detoxify poisons. The drug thalidomide was tested on rats with no adverse reactions, yet that was certainly not true for humans.

Testing of new chemicals requires testing only for acute reactions and only in isolation. Yet in actual usage, few chemicals are actually used in isolation. (Consider the number of different cleaning agents one might use in a single day's cleaning!) Testing is completed by the manufacturers who wish to market the product, with the results submitted to the EPA.

IMPLEMENTATION
1. Ask students how they would find out what ingredients are in a household product and whether it is safe to use.

2. Explain that by reading a label we can be aware of some of the toxins around us, but that labels do not list all ingredients and are not required to advise consumers of the acute or chronic effects resulting from use of a product.

Explain that consumers may suffer reactions from using certain chemicals. Acute effects are immediate reactions – getting jittery after drinking coffee or soda with caffeine is a mild example. Others may include nausea, headaches, or lightheadedness. Chronic effects may appear a long time after exposure to a toxic substance. They may be the result of excessive exposure over a long period of time (cigarette smoking leading to lung cancer) or the result of minimum exposure to a dangerous substance. Researchers have found that only brief or infrequent exposure to a carcinogenic substance may be all that is needed to alter certain body cells irreversibly. Liver and kidney damage, central nervous system damage and cancer are among chronic effects from toxic substances. Birth defects can be yet another reaction to toxins: a teratogen is a toxic substance which affects a developing fetus (include cigarettes, alcohol, drugs, and many chemicals). A mutagen can affect the unborn by altering the cells in a parent's body with those changes passed on in the cells of the offspring.

Distribute worksheets. Discuss/brainstorm ways to reduce exposure while using the products listed on the "Warnings!" sheet (ventilation, protective clothing, etc.). Have students examine their mini-dictionary, defining any unfamiliar terms as necesssary.

Upon completion, the chart may be reproduced on the board for dicussion purposes. Students may recognize that there are some toxins which pose such severe threats that precautions for the user would be inadequate. Then discuss the option of making an informed choice as a consumer not to purchase such products, and the consequences of such a decision.

Explain to students that the laws requiring labeling of household substances are limited. One reason for this is the manufacturers' desire to protect their products from competitors. Thus, companies don't want to divulge the list of ingredients contained in their products. Some pressure is being applied through worker right-to-know laws. Companies are now required to notify workers who will be using toxic substances and to provide adequate protection.

Consumers, however, may be unknowingly exposed to toxins. Some shampoos, for example, contain captan, a chemical shown to cause cancer. Yet such shampoos are not labeled with that information (or even with all ingredients), forcing consumers to make uninformed choices. Encourage students to discuss the dilemma of manufacturers' rights vs. consumer rights, assigning roles to students to represent all sides of the debate.

VOCABULARY

toxins	acute	chronic	irritant
carcinogen	teratogen	mutagen	corrosive
ventilate	isolation		

EXTENSION

Students may compare "Warnings!" sheet ingredients list with actual products found in their homes.

In a group or individually, have students examine actual labels of toxic household products. Encourage them to try to determine:

a) what ingredients are contained in the product? (note: not all ingredients are listed!)
b) which of these ingredients are toxic?
c) what precautions should be observed by the user?

Discuss what additional information would be useful to the consumer (full list of ingredients, chronic and acute effects, interactive effects of ingredients with other products, antidote, proper disposal techniques). Using the addresses on product labels, have each student compose and send a letter to a manufacturer seeking answers to the questions raised. When responses are received, display and compare the information gathered to determine the safest consumer choices.

DICTIONARY OF TOXINS
Potential Health Effects of Certain Chemicals

ammonia vapor irritates eyes, skin, nose, and lungs; may cause long term damage to these organs

ammonium hydroxide vapor is extremely irritable to skin, eyes, nose and lungs; swallowing causes tissue burns

benzene flammable; causes cancer; builds up in fat, bone marrow and liver tissue

cadmium suspected of causing cancer in animals as well as birth defects; may cause kidney damage

carbaryl causes cancer; causes kidney damage; respiratory irritant

dichlorvos possible cancer causing agent; may damage genes

diethylene glycol causes central nervous system depression and destroys tissue in liver and kidneys

ethylene glycol very toxic; 3 ounces can kill an adult; damages cardiovascular system, blood, skin and kidneys

formaldehyde causes cancer; irritates eyes, nose, throat and skin; may cause nausea, headaches, nosebleeds, dizziness, memory loss and shortness of breath

hypochloric acid causes burns from skin contact or inhalation; ingestion may be fatal

lead damage to most major body systems including digestive and nervous systems; results in anemia and brain damage

lye destroys body tissue; mists, vapors and dusts cause small burns

methanol moderately toxic; ingestion may cause coma or respiratory damage

methyl alcohol flammable; damages eyes, skin and central nervous system

methylene chloride may cause cancer; causes liver and kidney damage in animals

nitrosamines causes cancer in animals; can cause liver damage, jaundice and fever

oxalate see hypochloric acid

perchlorethylene damages liver and kidneys; breaks down slowly; may cause cancer

phenols flammable; very toxic; damages heart, respiratory and circulatory systems

potassium hydroxide eats away at all body tissues

sodium acid sulfate see hypochloric acid

toluene may cause reproductive problems; irritates eye and respiratory system and skin

trichloroethane damages liver and kidneys; breaks down slowly

xylene may cause reproductive problems; damages liver and kidneys; can cause skin problems

2,4-D causes liver and kidney damage in animals; may cause convulsions and skin problems in humans

The health effects found in this list focus on long term problems. It should warn you of the dangers of some chemicals. The full effect of a chemical on a person's health is not known. Little is known about the combined effects of most chemicals; that is, what happens when one chemical is used with others.

It is important to note that some people may be more sensitive and react more easily to certain chemicals. Different people react differently to toxins.

Name _____

WARNING! WORKSHEET

DIRECTIONS: Pick eight products from the "Warning!" sheet. Using the "Dictionary of Toxins", look up the health effects of the chemicals found in those products. List them on the chart. Then think of two ways to lessen the risks of using that product. An example is done for you. Continue the chart on the back of your paper.

PRODUCT	TOXIC SUBSTANCES	HEALTH EFFECTS	WAYS TO REDUCE EXPOSURE
flea powder	carbaryl	causes cancer, kidney damage, irritates respiratory tract	1. apply outside 2. avoid close, long-term contact with animal after application.

WARNING: These Products May Be Hazardous To Your Health!

Lesson III

MR. CLEAN STRIKES AGAIN!
Mathematics

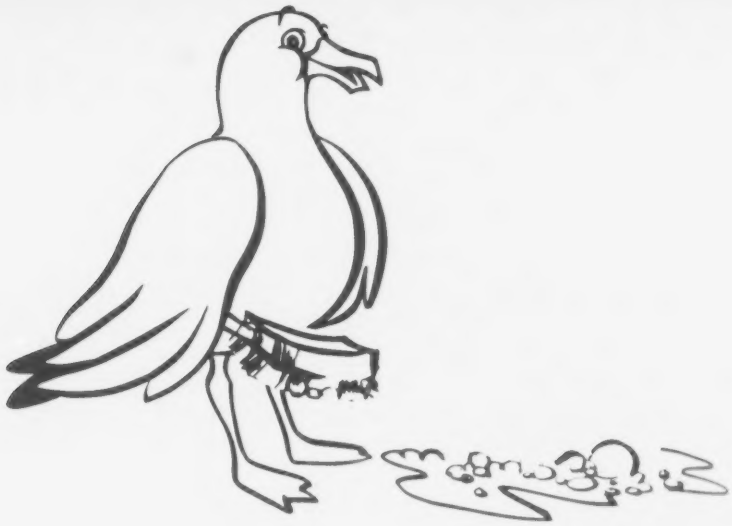
Students will apply mathematical processes to figures concerning consumption of cleaning materials in order to gain an understanding of the magnitude of the problem.

MATERIALS NEEDED
Worksheet (one per student)

IMPLEMENTATION
Distribute copies of worksheet. Review mathematical processes, if necessary. This worksheet includes addition, subtraction, and multiplication of decimals. Identify the operation to be applied to each problem, if necessary.

Remind students to use 365.25 for "days in the year" and 2000 to convert tons to pounds.

Have students complete worksheet. Discuss their findings. Help them to realize the environmental impact these cleaners are having on our waters and landfills.



MR. CLEAN STRIKES AGAIN!

About 945,000 people live in Rhode Island. Each day, people all over the state do their dishes, their laundry, their housecleaning. Large amounts of cleaning materials are washed into our sewage systems and then out to Narragansett Bay. Some contain chemicals that are harmful to fish and other aquatic life. How much do we use? You'll be surprised!

ESTIMATED HOUSEHOLD CLEANERS USED PER DAY BY RESIDENTS OF RHODE ISLAND.

	tons per day
1. abrasive cleaners	.30
2. disinfectants	.32
3. furniture polish	.07
4. drain cleaners	.21
5. liquid household cleaners	4.27
6. glass cleaners	.42
7. toilet bowl cleaners	1.24
8. liquid dish detergent	6.45
9. dishwasher detergent	3.78
10. liquid laundry soap	4.60
11. powdered laundry soap	19.97
12. fabric softener	10.85
13. bleach	10.36

NAME _____

1. If .30 tons of abrasive cleaners are used each day, how many are consumed in one year?

2. In one year, we use 7294.04 tons of powdered laundry detergent. How many pounds is that?

3. How many pounds of dishwasher detergent are produced daily?

4. Monday is wash day. People will use products 10 – 13 to do their laundry. What are the total tons of cleaners used?

5. How much more liquid dish detergent than dishwasher detergent is used each day?

6. How many tons of liquid household cleaners are used each year?

7. What is the difference in amount of powdered vs. liquid laundry detergent soap produced daily?

8. How many tons of cleaning materials are used daily in Rhode Island?

9. If everyone in Rhode Island stopped using glass cleaners and used vinegar and water to clean windows instead, how many tons of hazardous waste would that eliminate in 10 years?

10. If people stopped using fabric softeners in their laundry, how many tons of waste would be eliminated each year?

BONUS: BASED ON THESE ESTIMATES, HOW MANY TOTAL POUNDS OF WASTE FROM HOUSEHOLD CLEANING PRODUCTS DOES RHODE ISLAND PRODUCE EACH YEAR?

Teacher's Page

1. If .30 tons of abrasive cleaners are used each day, how many are consumed in one year?

.30 x 365.25 = 109.575 tons

2. In one year, we use 7294.04 tons of powdered laundry detergent. How many pounds is that?

7294.04 x 2000 = 14,588,080 pounds

3. How many pounds of dishwasher detergent are produced daily?

3.78 x 2000 = 7560 pounds

4. Monday is wash day. People will use products 10 – 13 to do their laundry. What are the total tons of cleaners used?

4.60 + 19.97 + 10.85 + 10.36 = 41.18 tons

5. How much more liquid dish detergent than dishwasher detergent is used each day?

6.45 – 3.78 = 2.67 tons

6. How many tons of liquid household cleaners are used each year?

4.27 x 365.25 = 1559.6175 tons

7. What is the difference in amount of powdered vs. liquid laundry detergent soap produced daily?

19.97 – 4.60 = 15.37 tons

8. How many tons of cleaning materials are used daily in Rhode Island?

62.84 tons

9. If everyone in Rhode Island stopped using glass cleaners and used vinegar and water to clean windows instead, how many tons of hazardous waste would that eliminate in 10 years?

.42 x 365.25 x 10 = 1534.05 tons

10. If people stopped using fabric softeners in their laundry, how many tons of waste would be eliminated each year?

3962.9625 tons

BONUS: BASED ON THESE ESTIMATES, HOW MANY TOTAL POUNDS OF WASTE FROM HOUSEHOLD CLEANING PRODUCTS DOES RHODE ISLAND PRODUCE EACH YEAR?

62.84 x 365.25 x 2000 = 45,904,620 pounds

Lesson IV

WHO KILLED COCK ROBIN?
Reading/Comprehension

Students will listen to a story concerning environmental effects of pesticides and display their comprehension by completing reading worksheet.

MATERIALS NEEDED
Worksheet (one per child), overhead projector

SOURCE
WHO REALLY KILLED COCK ROBIN?

BACKGROUND
One billion pounds of pesticide are sold annually, 15% to home and garden users. Less than 5% of the 35,000 commercial preparations in use as of 1972 have been tested to meet current safety standards. At that time, passage of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) "grandfathered" all existing pesticides. EPA registration of a pesticide does not, therefore, guarantee its safety. By April of 1982, about 30 substances had had registration cancelled or uses suspended due to human or environmental problems.

Pesticides and fertilizers are employed by homeowners mostly on weekends, and mostly in the spring. Eighty-five to ninety percent of all yard and garden pesticides are applied within a six week period, from the end of April to early June. If rain occurs within 3 – 5 days of application, it will carry off applied liquid pesticide. Therefore,a dry spring weekend (good for applying) followed by a wet week has the greatest potential for contamination of runoff waters. When fertilizers are washed into water, algae and other plant life grow. This depletes the available oxygen for aquatic life. Also, nitrates used in fertilizers can poison wells and aquifers through runoff (as in the Temik problem in South County).

IMPLEMENTATION
Explain to students that you are going to read aloud a mystery to them. Tell them that their job will be to analyze the details and try to determine "Who Did It?" Distribute student worksheets to students prior to reading the story, to help them focus on important details while listening. Read aloud *Cock Robin* by Jean Craighead George. Have students complete worksheet individually. Discuss results, allowing for different interpretations of motive and characteristics. Display overhead, leading students to solve the mystery.

VOCABULARY

degradation	bioconcentration	bioaccumulation
persistence	food chain	motive
aquifer		

NAME _____

WHO DID IT?

Motive is important in understanding a story. Think of one thing that each of the human characters did in the story. Try to figure out why he or she did it. The robins' behaviors have explanations, too. But they are rooted in nature.

WHO?	DID WHAT?	GIVE FIVE WORDS THAT DESCRIBE THIS CHARACTER
Tony Isidore		
Mary Alice Lamberty		
Mayor Joe Dambrowski		
Izzy Isidore		
Frank Lamberty		
Editor David Lowenthal		
Cock Robin		
Mrs. Robin		

Cock Robin

JEAN CRAIGHEAD GEORGE

Cock Robin lay on his back with his feet in the air. A red breast feather twisted in the wind, his clove-brown wings folded like a dancer's fan. It was seven minutes past six A.M. on the twenty-fourth of May. He was dead.

Many robins have died without notice by the human race. But this was a particular robin, the Cock Robin of Saddleboro, and his death was a crisis.

At nine minutes past six on that memorable morning, the telephone rang in the kitchen of 65 Elm Street. It awoke Tony Isidore, who was sleeping in his room at the top of the back steps. He stumbled downstairs to answer it. He grabbed the receiver and mumbled, "Hello."

"Cock Robin is dead!" a voice exclaimed. It was Mary Alice Lamberty, the daughter of the wealthiest man in town.

"He's dead!" she repeated. "Mayor Joe just called my father. He accused Daddy of killing Cock Robin because our mill still dumps aniline dyes in the river. This is not true."

"Why are you telling me?" asked Tony.

"You know perfectly well why I'm telling you. The Mayor gets all his information about robins from you, and he's going to ask just who killed Cock Robin. I know he will; and I just want you to know right now that if anyone murdered him, it was the Mayor with all his fancy garden sprays."

Mary Alice hung up before Tony could say anything. He shrugged and went back to his room. Then he picked up his field glasses and focused them on Mayor Dambrowski's lawn across the street.

There lay Cock Robin with his feet in the air. Several silver-winged bugs slipped out of the bird's feathers and disappeared into the grass. Their departure was as sure a sign of the robin's death to Tony as rats deserting a ship are a sign of its sinking. His brow crinkled with sadness. He picked up a small notebook and opened it.

The first entry was dated April 29: "A male robin arrived in the maple tree across the street just after sunup," he read. "He hasn't sung yet, so I don't know if he is on his way to Canada or is home. However, he acts as if he were home. He is inspecting the limbs of the trees, preening his feathers, and looking down on the yard."

The next note was dated April 30: "The male bird in Dambrowski's yard sang the territorial song of the robin who is home from the South." Farther down on the same page Tony saw that he had made a note of other male robins. "One is singing somewhere near the library. Also in the Town Park. Also on Pine Street."

Tony was keeping these notes for his older brother Izzy. Izzy was making a study of the robins of Saddleboro. But he had been drafted into the army before he had been able to finish the study. A few days before he left last fall, he had asked Tony to keep tabs on "his" birds when they returned in the spring. Tony was flattered by the responsibility. He assured Izzy that he would do his best.

"Good notes are the basis of scientific research," Izzy told him. "If you take them well, they'll reveal the truth." He had then taken Tony around the town again, told him to jot down the weather, plants, anything unusual or even usual, and then suggested Tony make one round alone. When Tony came home, Izzy was surprised by his younger brother's powers of observation. He had given Tony a pat on the back.

Six months had passed since then.

Tony studied his notes. He went to Izzy's office-bedroom to brief himself for the phone call from the Mayor that Mary Alice had told him to expect. He took out a map of bird territories. He saw that where there had been many pairs of robins four years ago, there now were very few. He was shocked. Like all the people of pollution-fighting Saddleboro, Tony had thought that there were more, not fewer robins. Since Mayor Joe and his Clean Environment Party had come into power, everyone thought that Saddleboro was a town where man, plant, and beast were in balance.

Mayor Joe, as he was called, had been elected to office after campaigning against DDT, automobile exhaust, and the sewage pollution in the Missatonic River that runs past Saddleboro. He had had a sewage-disposal plant built in the town. He also walked to work instead of driving, to avoid putting carbon dioxide and lead in the air. He organized the children and asked them to find every can that contained DDT. These were buried in wet cement near the town dump. After that, everyone agreed that the river was clearer, the birds sang louder, and the air was much sweeter in Saddleboro.

And then on April 29, Tony observed the male robin on the Mayor's lawn. On May 3, the bird was on his way to becoming the famous Cock Robin of Saddleboro. This was when his mate started building a nest in the Mayor's Stetson hat, which he had left on the iron planter on his front porch.

The Mayor saw the robin as an answer to the Clean Environment Party's prayer. He and the editor of the local newspaper, ***The Patent Reader,*** had been trying to think up a new gimmick to promote the Mayor in the fall elections. Here it was – Cock Robin in that old hat! The next day the paper carried a picture of the grinning Mayor pointing to his Stetson. The caption read:

COCK ROBIN HAS PICKED DAMBROWSKI, THE MAN WHO IS RESPONSIBLE FOR SADDLEBORO'S UNPOLLUTED WATER AND AIR.

On May 4, Tony had gone to speak to the Mayor about the robins. Mary Alice Lamberty arrived at the gate just before he did. Tony waited by the hedge as Mary Alice spoke with the Mayor. Tony heard the Mayor say that Cock Robin had sung to Mrs. Robin at five-thirty A.M., and so thrilled the lovely female that she had joined him on the lawn for breakfast.

On May 7, Tony got out of bed and turned on the radio. He heard an ad for the "Cock Robin Hour – a living narrative by our Mayor. The story of bird home-life as it happens." Tony was listening, as were a good number of other Saddleboro residents, when the program began at seven A.M. The Mayor began by saying that he had a microphone in his living room. He then described Mrs. Robin flying to her nest with a bright piece of yellow cloth

He said she wove it into her nest. "Her home now looks like a party house, and Cock Robin is pleased. He is dancing."

Tony thought the Mayor ought to know what the decoration meant. He walked over to the Dambrowski house.

"Sir," he said politely when the Mayor answered his knock, "a robin decorates her nest the day before she lays an egg. It takes her about four or five days to build her nest, one day to put in the lining of rootlets, and one day to decorate. Then, if it doesn't rain and soften the mud, she will lay the next day."

The Mayor asked Tony how he knew this. Tony told him about his brother and the notes he had been taking for him. The Mayor said he was sure he would want to talk to Tony again. The Mayor hurried to the gate where Mary Alice Lamberty and two of her friends were waiting. "Guess what?" Tony heard him say. "Tomorrow Cock Robin will be a proud papa."

The next day, May 8, the newspaper carried a banner headline about the blessed event. Tony turned on his radio and heard the Mayor's voice. He described the pretty egg and Cock Robin's singing about it. Male robins never announce eggs, nor do females, but Tony forgave the Mayor for his error. Then the Mayor cleared his throat. "Frank Lamberty of the Missatonic Mill," he said, "is celebrating this event in a particularly wonderful way. He will stop dumping aniline dyes in the river. He is going to purchase a tank truck to cart off the dyes to the dump. The fish that have been poisoned by the dyes in the past will now be able to live in clean water. Thanks, Frank."

Tony picked up his schoolbooks and went to the back door. As he opened it, the Mayor was there to greet him. Mayor Joe asked in a worried voice why there was only one egg. He thought robins had five. Tony explained that songbirds lay one egg a day until their clutch is complete. "Four or five is a clutch for a robin," he said. "Then the female starts to incubate so that they all hatch at once." The Mayor seemed pleased with this information. He nodded and hurried across the street.

For the next four days the newspaper announced each new egg. When the fifth egg was laid, the Mayor phoned Tony and asked him what came next. Tony said that the female would now breed the eggs and that this interlude was known as the "incubation period." He added that both birds would change their behavior during this time. Tony started to tell the Mayor just how, but the Mayor hung up.

"Cock Robin Hour" opened the next morning with the announcement by Mayor Joe that "The incubation period has begun. Mrs. Robin is on her nest. She is touching each of her five eggs and moving them."

On the fifth day of incubation, Tony waited for the Mayor at his back door and suggested that perhaps Cock Robin was not well. "Today," Tony said, "you mentioned that he was sitting on the roof of your garden tool shed singing 'loud rock songs.' Rarely does a male robin sit in the open and sing when his mate is incubating. He's usually very quiet, so as not to attract predators. I hope he's all right."

"And by the way," added Tony, "Mrs. Robin was not just moving her eggs the other day. She was turning them so that the embryos would not stick to the shells."

The Mayor didn't say too much about Tony's information. But the next morning he opened his program with a dramatic speech about how Mrs. Robin turned her eggs to keep the embryos from sticking to the shells.

That afternoon Tony was passing the newspaper office when he heard his name shouted. He turned and saw David Lowenthal, the editor of *The Patent Reader*, beckoning him.

"How long's this incubation period?" Lowenthal asked when they were in his office.

"Twelve to thirteen days," Tony replied promptly. "But since there was a frost the night before Mrs. Robin started incubating, I'd say thirteen for her."

Lowenthal picked up the phone and dialed.

"Joe!" he shouted. "Listen, that robin is going to sit on those eggs for another seven days. Then there'll be babies. Let's have a big rally and celebration. Call it 'Cock Robin Day' and get everyone together for some speeches and fun."

The editor grinned and said it was just a little idea he'd had to get the folks together in the Town Park for some propaganda about Saddleboro's victory over pollution. "I'll go down to the park when it's all over and write a story about how Saddleboro is leading the nation in cleaning up picnic grounds. If I write it well, the wire services might pick it up. You'll get statewide publicity. And my circulation increases every time we run a robin story."

Lowenthal hung up the phone and looked up at Tony. He smiled and said, "Thanks for the information."

The next morning Tony listened to the "Cock Robin Hour" while he dressed. When the Mayor described a "jazzy Cock Robin," Tony dashed downstairs to get the newspaper.

He turned immediately to the weather page. Tony was glad to see that the weather showed no signs of changing from sunshine to rain. That would be disastrous. The Mayor had said Cock Robin was "sitting on his tool shed all puffed up and looking like a proud papa." To Tony that meant he was sick. A cold, rainy night might take his life before the picnic on May 25. He phoned the Mayor's house to warn him, but the Mayor was not at home.

In the newspaper the next day was an announcement that Mayor and Mrs. Dambrowski would serve fresh lemonade – no bottles, no cans, no artifical flavoring – to all the kids who came to the park after school to pick up and prepare it for Cock Robin Day. That sounded good to Tony.

Late that afternoon, Tony got his lemonade. He was carrying it across the baseball diamond when he noticed that the ground was covered with anthills. He collected some of the ants and took them home to look them up in his insect book. They were yellow ants that never appeared in vast numbers unless there were no insect predators, like spiders or birds, to control them. They represented a missing link in the food cycle. He mentioned this to the Mayor the next morning.

"Lots of ants?" Mayor Joe said. "They might spoil the picnic."

"They mean something is wrong with the ecology of the park. Saddleboro is not as clean as we think it is. There must be something wrong for there to be so many ants ... like trillions of them."

That night Mayor Joe called Tony and asked him if he knew of any safe pesticides.

"Yes, pyrethrum, rotenone, serin. Do you mind if I ask why?"

"Dave Lowenthal and I went down to the park, and there are quite a few ants around. We'd like to get some safe sprays for them. Dave will write a story about them."

"Oh," replied Tony. "I'll give him some of my brother's notes on biological controls. Parasites that kill beetles. They're even better than sprays."

On the eleventh day of incubation, Mayor Joe sounded concerned as he spoke on the air.

"Mama's off the nest," he said. "She's been gone since six A.M." He went on to say that Mrs. Robin never stayed away from her eggs longer than ten or fifteen minutes. He also added that he had seen Cock Robin call Mrs. Robin from her eggs when she needed to eat. She had dined until Cock Robin had felt it was time for her return. He had then sung a song that sent her home.

"I'll stick around the house this morning and let you know when she comes back."

At five minutes to eight Mayor Joe announced that Mrs. Robin was back on her eggs. Tony dashed around his house to warn him that the robins were not well, but the Mayor had left for work.

The next day Mayor Joe came on the air and said of Cock Robin: "He looks mighty proud."

When Tony was ready to leave for school, the Mayor was again at his door.

"I'm really concerned about Cock Robin," he said. "He's been sitting on the tool-shed roof all morning. He hasn't flown once, just twitches. What does that mean?" Tony looked at Cock Robin. "He doesn't look good," he said. "When a bird fluffs up as much as that he's sick. Maybe you shouldn't talk about him until we find out what's wrong . . . just talk about Mrs. Robin."

The Mayor announced the following morning that Cock Robin was leaping from the shed roof to the ground in great excitement. "He's like a father pacing the floor of the hospital."

"See you the day after tomorrow," he sang out. "Saddleboro will have five beautiful baby robins to cheer about."

Tony ran out of his house, sped to the Mayor's back door, and boldly knocked. When the Mayor appeared, Tony told him something was wrong. Cock Robin was not pacing like a father in a hospital at all. He was so poorly coordinated that he was flopping. "He's sick, and he's trying to get away from the marsh hawk," he said pointing to a large, broad-winged bird above the Mayor's house.

"The marsh hawk?"

"Yes, he's been circling your house since dawn."

"I'll shoot him!" the Mayor exclaimed.

"Don't do that. He's important in ecology, too. He takes sick animals away and leaves the well ones."

Just then Mary Alice came around the corner.

"How are the Cock Robins?" she asked.

"Fine, fine, the little mother is getting used to me," the Mayor said proudly. "She cocks her eye when I peek out the curtain and chirps softly. Now run along, Mary Alice; I must talk to Tony. He's my robin aide. Get all my information from him."

After Mary Alice had left, Tony turned to the Mayor to talk about what robins eat. He told him that robins do not feed their hatchlings earthworms. They feed them the green larvae of the cabbage looper. These, he added, are terribly scarce. He had not seen one all spring. "I'm worried about the food supply. I still think those trillions of ants mean that some animal is missing from the food chain for some mysterious reason. Something is wrong in Saddleboro," Tony said, "but I don't know enough to know what it is."

At nine minutes past six the following morning, the phone rang in the kitchen of 65 Elm Street and Tony Isidore got the word from Mary Alice that Cock Robin was dead. He sprinted to his bedroom window, picked up his field glasses, saw the robin was dead, and noted the details.

Walking slowly into Izzy's room, he stared at the pile of ecology maps. Then he thumbed through Izzy's notes. The telephone rang for a second time. He ran downstairs, and as Mary Alice had predicted, it was Mayor Joe.

"Tony, Cock Robin is dead! Find out who killed him."

Read this after showing the overhead projection of the contaminants found in Cock Robin.

BUT WHO REALLY KILLED COCK ROBIN?

Although his body contained many pollutants, there were not enough of any one of them to have killed him. A newspaper article and Tony's notebook give the final answer.

NEWSPAPER STORY

Homestead, Florida. Ten thousand birds were killed in a field near here when they ate seeds treated with mercurial compounds. The birds killed were primarily Savannah sparrows migrating north. The U.S. Department of Agriculture has now banned mercurial treatment of seeds. However, the disaster has had a chain effect. When the sparrows died, millions of parasitic flies left their bodies. These attacked the next wave of the bird migration, which was largely thrushes. (Robins are thrushes.) Since these parasites suck the blood of birds, many thrushes were weakened and died along the migration route.

TONY'S NOTEBOOK

"Friday, May 24, 6:10 A.M. Cock Robin is on his back. He is dead. Must be. Flylike insects with glassy wings are creeping off his body like rats abandoning a sinking ship."

Used with permission of the Publisher.

BODY OF COCK ROBIN CONTAINED:

PCB	DDT
Used in making plastics, fabrics, building and paving materials. Fabric containing PCB burned at dump. Fumes covered plants. Birds ate plants. Prevented three of Mrs. Robin's eggs from hatching. Frogs absorbed PCB through their skins and died. Smell of PCB drove marsh hawk away.	Used as a pesticide. Farmers 20 miles away spray trees with DDT. Wind brought DDT to Saddleboro. Coated leaves and grass. Cabbage loopers ate leaves and grass. Almost wiped out cabbage loopers.

2,4,5 T	Mercury
Used as weed killer. Sprayed around electrical power poles to keep weeds from growing. Birds and spiders ate weeds. One of the baby robins that hatched had enough 2,4,5 T in him to kill him. Other lived, but could not make sounds. Kept spiders from reproducing. (These spiders ate yellow ants. Fewer spiders meant more ants.)	Used in fungicides. Sprayed on Mayor's lawn to keep it green. Seeds coated with fungicide used by farmers. Birds ate seeds and grass. Killed fish in Missatonic River. (Water from Mayor's lawn drained into river.)

Lesson V

WHERE DOES IT GO?
Reading/Problem Solving

Students will become familiar with common disposal practices and apply group problem solving techniques to situations.

MATERIALS
Student reading sheet (one per student), "Where *Should* It Go?" (one per student), copies of Problem Solving Exercises, cut into cards, (one card per student); Decision Sheet (one per group)

SOURCE
SLEUTH

IMPLEMENTATION
Read *Everywhere is Somewhere* to class. Distribute student reading sheet and "Where *Should* It Go?". Have students discuss the information. Then tell students that they are going to role play the decision making process for dealing with some common household hazardous substances. Divide the class into 3 groups, assigning each group a different problem or allowing all 3 groups to examine each of the problems. Allowing 10 – 15 minutes for discussion, instruct each group to make a recommendation/decision concerning their dilemma. Have an assigned scribe keep track of the discussion (on the Decision Sheet) in order to reveal to the class what factors were taken into consideration prior to achieving a consensus.

Note that there is not necessarily one correct answer to these problems. They are current, real problems for which our state and society are trying to find good solutions! Encourage students to take "Where *Should* It Go?" home with them, to share the information with their families.

SCENARIO #1: Hilda discovers a can of gasoline in her garage. What should she do with it? If she decides to dispose of it, what options does she have?

SCENARIO #2: A group of neighbors is setting up a community gardening project. They have purchased the plot of ground and are meeting now to make some decisions about policy. The first issue they decide to tackle is whether to use Slug Bait in their garden.

SCENARIO #3: Nine individuals who have operated independent cleaning services have decided to combine their talents to create the Zippy Cleaning Service. As a group they need to make some decisions about the products they will use and the policies they will follow.

VOCABULARY

sewers	septic tanks	wastewater
groundwater	degradation	persistance
bioconcentration	bioaccumulation	

EVERYWHERE IS SOMEWHERE

When people spray poisons into the air
to kill plant-eating insects,
the insects may die
but the poison does not go away.
It stays, unseen, in the air.
And it falls, perhaps years later,
on other plants, and on the land.
When the rains come, some poisons wash off plants
and run off the land
into ponds and lakes and rivers.
The poison is always somewhere.
It gets into water plants
and small water animals
and into the fish that eat them.
Birds of the air catch the poisoned fish,
or eat the poisoned insects,
and poison gets into the birds.
The poisoned birds lay eggs with soft eggshells.
No baby birds will come out of these eggs.
Some kinds of birds will never fly through the air
again.
They are gone forever,
because of poisons in the air.
In the air, everywhere is somewhere.
Nowhere is away.

When you rinse garbage down the drain of a sink,
or flush trash down the toilet,
it does not go away;
it goes somewhere.
Sewage and waste go into big pipes.
The pipes go into the river;
The river runs into a bigger river.
The big river flows to the sea.

Far, far away
in the middle of the ocean,
garbage and trash float on the sea water.
Pollution does not float away;
it floats somewhere.
And it will stay there,
floating and sinking under the sun,
for years and years.

When you rinse something down the drain,
it does not go away –
it goes somewhere.
In the water, everywhere is somewhere.

Betty Miles, "Save The Earth! An Ecology Handbook for Kids,"
Used with permission of the publisher.

WHERE DOES IT GO?

When you wash your clothes in sudsy detergent, where does it go? When you clean your sink with cleanser, where does it go? When you pour a waste into a street drain, where does it go? It doesn't disappear; it all goes somewhere. It all helps or hurts someone or something.

All the drains in your house lead from the bathroom, kitchen, and laundry room down to one large drain. The watery wastes pass into a septic tank, if you live in the country. A septic tank is a large underground concrete container. Wastewater spends two or three days there. Solids settle to the bottom of the tank. Liquids are piped into a drainfield which allows them to seep slowly into the soil. The solid sludge must be pumped out every five years. It's then taken to a sewage treatment plant.

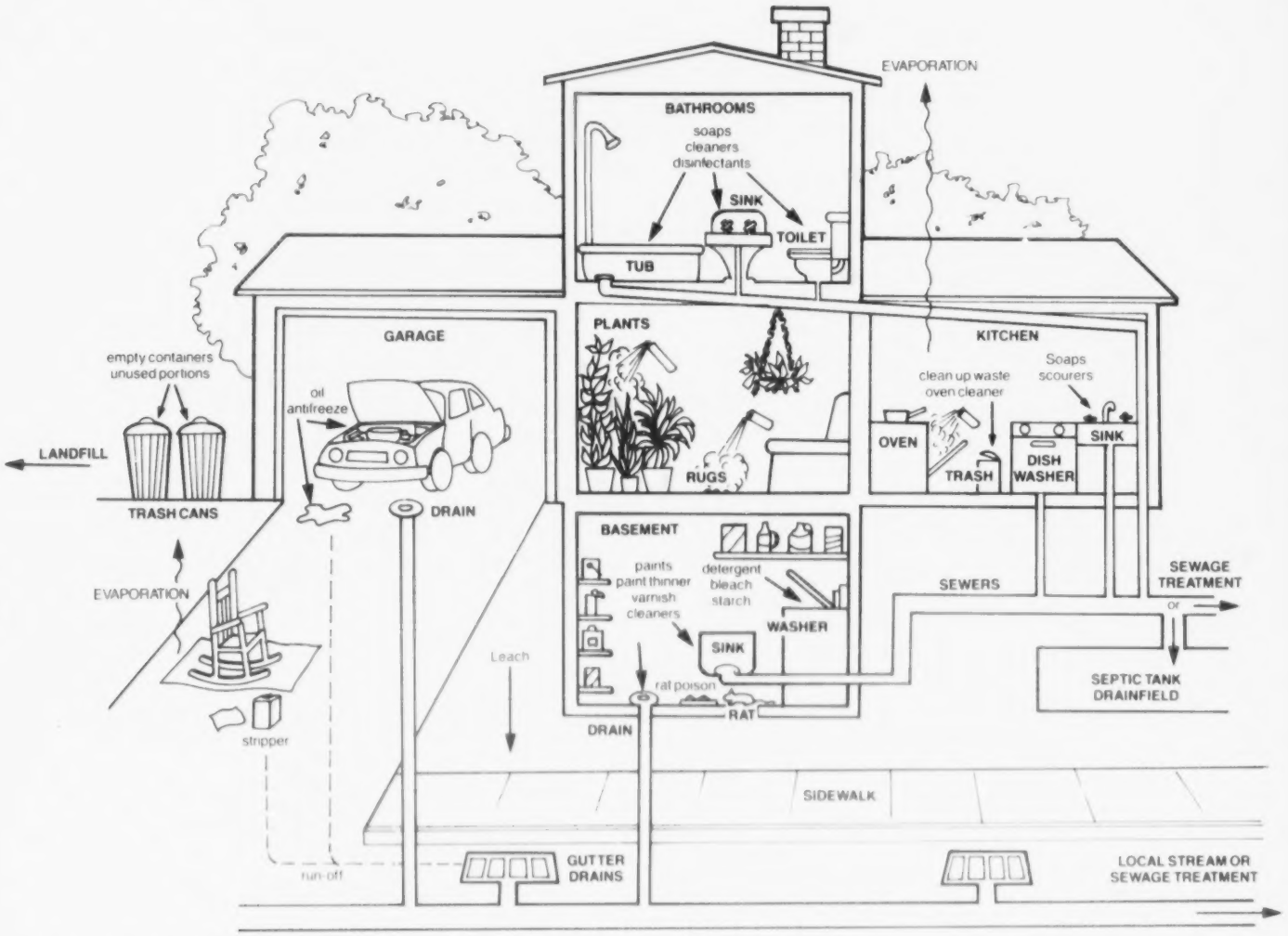
If you do not have a septic tank, then your wastewater is piped from your house to the sewage treatment plant. Underground pipes mix the liquids from homes, stores, and factories. At the sewage plant, wastewater is treated with bacteria. This can remove only some of the harmful materials. Then the waste is diluted with water and discharged into nearby lakes or streams.

Pouring wastes into storm drains is illegal. That's because they lead directly to waterways. Any chemical could harm the fish, or poison humans who eat the fish.

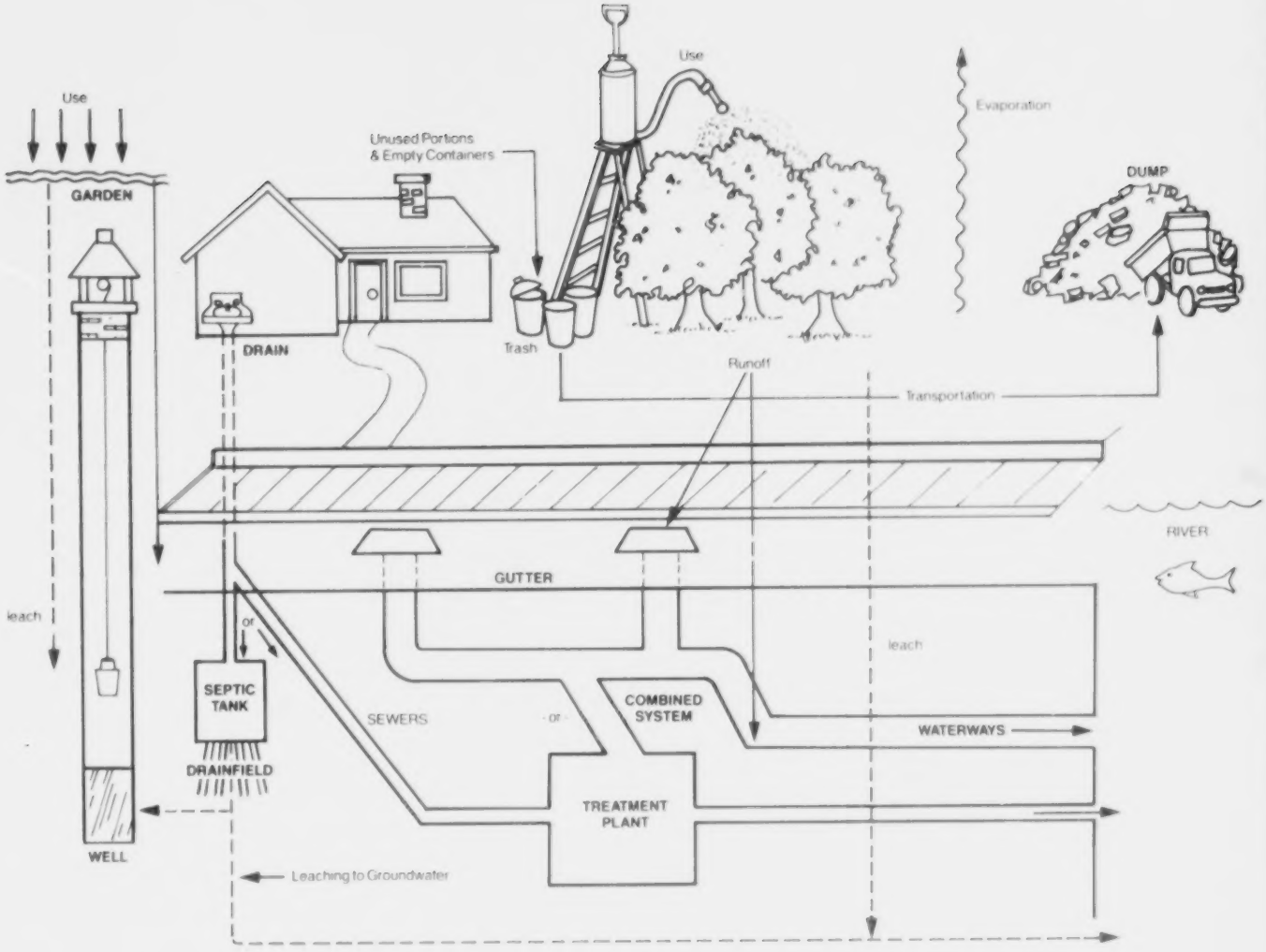
Dumping wastes on the ground pollutes the soil. As the poison seeps into the soil, groundwater supplies may be ruined.

Burning toxic wastes isn't a good idea, either. Harmful gases contaminate the air. Aerosol cans will explode.

There are only two good solutions to toxic wastes. Use as little as possible. Then dispose of any wastes at a Toxic Cleanup Day.



Adapted from: Sleuth – Educational Activities On the Disposal of Household Hazardous Waste, METRO, Seattle, WA



Adapted from: Sleuth – Educational Activities On the Disposal of Household Hazardous Waste, METRO, Seattle, WA

WHERE SHOULD IT GO?

DOWN THE DRAIN WITH LOTS OF WATER

- powder cleaners
- window cleaner
- toilet cleaners
- bleach

EVAPORATE SMALL AMOUNTS OUTSIDE AWAY FROM CHILDREN AND PETS. THROW RESIDUE IN GARBAGE CAN.

- latex paint

TAKE TO HOUSEHOLD HAZARDOUS WASTE COLLECTION SITE

- pool cleaning agents
- drain cleaner
- silver polish
- flea powder
- furniture polish
- kerosene
- auto antifreeze
- mothballs
- spot removers
- house insecticides
- rat poison
- paint stripper

RECYCLE

- car batteries
- motor oil

Scenario #1
You are Hilda's neighbor, Nancy Nextdoor. You point out that gasoline evaporates. Maybe Hilda could just evaporate the gasoline. But you know that the fumes are dangerous – poisonous, in fact. There are small children in the neighborhood. You wonder, too, if evaporation might cause some air pollution.

Cut - - - - - -

Scenario #1
You are Lt. John Jones of the local fire department. It is very dangerous to store gasoline as it is a fire hazard.

Cut - - - - - -

Scenario #1
You are Hilda's brother-in-law, Fred. You tell Hilda that gasoline is an effective weed killer. Hilda has a large patch of blackberries in the corner of her lot. Maybe she should throw the gasoline on the ground around the berries.

Cut - - - - - -

Scenario #1
You are Joe Cleandrain from the sewage treatment plant. You can tell Hilda that it is against regulations to pour gasoline down the drain in her sink.

Scenario #1
You are Pat, a neighbor of Hilda's. You know that gasoline is a solvent. How could Hilda use a solvent? You suggest Hilda might check with a recycling center that takes solvents. But the one you know of is 25 miles away – clear over on the other side of town.

Scenario #1
You are Chris, Hilda's high school son's buddy. You say that your dad has always poured his excess gas down the storm drain or catch basin in front of the house. It is in such small quantities, it can't possibly hurt anything.

Cut - - - - - -

Scenario #1
You are Peter Putrescible, a representative of the central landfill. You tell Hilda that the landfill will not accept flammable materials.

Scenario #1
You are Hilda. You discovered a can of gasoline in your garage while you were cleaning. You don't know exactly how long it has been there. You worry that it may have water or oil or rust in it. You won't try to use it in your car for that reason.

Scenario #1
You are Hilda's son, Ralph. Another friend of yours says that his dad is glad when he has excess gasoline around. He uses it to start the barbeque.

Scenario #2
You are Bob Tool. You own the Valley Hardware and Garden Store. You know that Metaldehyde is the active ingredient in slug baits. It was first discovered in 1936 and has been around for a long time.

Cut

Scenario #2
You are Sally Street. You have used salt on the slugs in your own garden. Last year you used saucers of beer to get rid of them. The saucers had to be changed often though. Sometimes it seemed like a lot of work.

Cut

Scenario #2
You are Sandy Beach. You read in a gardening magazine that kelp or seaweed laid around the edges of the garden would get slugs. They crawl over the salty surface of the seaweed and the salt makes them dry up.

Cut

Scenario #2
You are Polly Puregard. You checked with the local "Grow Em" Community Garden people. They don't allow any chemicals in their community gardens. If this garden project allows chemicals, you don't want to participate.

Scenario #2
You are Ned Punchly. You suggest that boards be put flat around the individual beds. The slugs would crawl under them in the day time and someone could turn the boards over and collect or kill them. Or maybe the group could elect a member to go out at night with a flashlight and collect them.

Scenario #2
You are Susan Feathers. You recommend that the group build a fence around the garden plot . . . and then another fence 2 or 3 feet away from the first. This would make a "run" for ducks and geese that the project would put in there. They should take care of the slugs before they get into the garden.

Cut

Scenario #2
You are Rita Byeby. You recommend planting sacrificial rows of bok choy, or lettuce, or cabbage, or whatever, all around the perimeter of the garden. That way the slugs will be too busy to get inside the "real" garden.

Scenario #2
You are Dudley Doread. You brought a label from a slug bait container and know that it is toxic to pets. Some pets have been poisoned by accidentally eating it in the garden. You also have to keep it away from the edible parts of the vegetables. What does that mean?

Scenario #2
You are Johnny Goodgardner. You have tried very hard over the years to garden with a minimum of chemical pesticides or fertilizers. But you lost most of your lettuce last year to the slugs and that was a real pain. You also want the project to work out well and want everyone to feel comfortable with group decisions.

Scenario #3
You are very concerned about cleaners that come in aerosol containers. You know they are very popular but not very cost efficient. Small droplets can be dispersed throughout a room besides on the item being cleaned. Some propellants may cause environmental damage to the ozone layer around the earth. Also, disposal of aerosol cans is a problem. Cans can explode if they get too warm.

Annie Aerosol

Cut . . . . . .

Scenario #3
You have been looking into the amounts of hydrocarbons, petroleum distillates, and naphthas in polishes and cleaners. They can cause skin irritation and rashes, as well as eye, nose, throat and lung irritation. They are also hazardous if ingested – resulting in entry to lungs. Repeated exposure can cause liver and kidney damage.

Priscilla Polish

Cut . . . . . .

Scenario #3
You have researched some alternative cleaners. For general surface cleaning one recommendation was several teaspoons of vinegar in water, supposedly good for glass or marble. Baking soda is supposed to be good for other areas that are particularly greasy – i.e., coffee pots, chrome, copper, and tile.

Granny Smith

Cut . . . . . .

Scenario #3
You are concerned about disinfectants and deodorizers whose use constitutes disposal down drains or into the air. You know they do not create a germ-free environment anyway. You wonder about toilet bowl cleansers. They are disposed into the sewer. Does that create a problem?

Tom Smellnice

Cut . . . . . .

Scenario #3
You are concerned about alkalies found in dishwater detergent, some oven cleaners, and as lye in drain cleaners. Some phosphate laundry detergents contain some alkali. If swallowed, it could cause severe stomach pain and burns along the mouth and throat. If inhaled, causes severe coughing, can burn throat and lungs. Skin contact can cause burns. Eye contact causes burns, possible loss of cornea.

Carl Caustic

Scenario #3
You have researched an alternative to manufactured disinfectants:

¼ cup bleach in
1 qt. water

Bob Bleach

Cut . . . . . .

Scenario #3
You are concerned about the phosphates in detergents and TSP – a cleanser. You heard that phosphates can threaten lakes, rivers, and streams by encouraging algae growth.

Jack Cleanwater

Scenario #3
You are concerned with the human health hazards of chlorine. It is the base of some bleaches and drain cleaners. Chlorine can cause burns and surface damage to eyes. If mixed with an acid, chlorine gas is produced. It is highly toxic and can cause death. If mixed with ammonia, chlorine gas is produced. It is toxic. Especially dangerous to those who have lung problems.

Cloris Toxgas

Scenario #3
You have researched some alternatives to commercial furniture polishes:

1 teaspoon lemon oil
1 pint mineral oil

or
equal parts of:

turpentine
boiled linseed oil
vinegar
plus few drops of lemon oil for fragrance.

Lisa Lemon

PROBLEM SOLVING EXERCISES
Decision Sheet

Which Scenario? _____

Students in this group: _____

After each person contributes information and the entire problem unfolds, what do you see as the ISSUES in this exercise?

What are your POSSIBLE SOLUTIONS?	What would be the TRADEOFFS for that solution?	What environmental or human health EFFECTS do you see from that solution?

FINAL DECISION:

Was the entire group satisfied with that decision? If not, why not?

Note any COMMENTS and QUESTIONS that your group had during your decision making process. Discuss with the rest of the class.

Lesson VI

SOLVE IT
Math Activity

Students will apply mathematical processes to manipulate data pertinent to DEM's Toxic Cleanup Days.

MATERIALS
Student worksheet (one per child)

BACKGROUND
Toxic Cleanup Days are held throughout the state in order to give residents an opportunity to properly dispose of household hazardous wastes, thus protecting both people and our environment. Following collection, hazardous wastes are treated as follows: recovery, detoxification, or secure landfill.

To recover (recycle) means to use over again. Any batteries, acids, caustics, motor oil or solvents turned in could be recycled. Direct recovery means to reuse something either as it was originally intended (as motor oil can be reused after reprocessing) or for a different purpose. Indirect recovery means using one waste to treat or detoxify another.

Detoxification is the conversion of hazardous waste to non-hazardous waste. Wastewater treatment, incineration or biological treatment would be followed. A chemical incinerator, unlike a standard municipal incinerator, is monitored to insure proper destruction without release of harmful vapors. Organic pesticides, paints, paint removers, wood preservatives, petroleum products, acids, and caustics can be detoxified.

A secure landfill (different from a municipal landfill) is the last resort. Built over clay and bedrock, the landfill would have an inert liner to seal wastes. Collection of liquids above and below the liner serves as further environmental protection. Ash left from chemical incineration, paint solids, empty metal containers which previously held hazardous wastes and inorganic chemical solids must be placed in secure landfills.

IMPLEMENTATION
Distribute worksheet. Discuss the table showing participants and products disposed of in DEM's first round of Toxic Clean Up Days. Note that additional days have been held in Fall, 1985 and Spring, 1986.

Review mathematical processes, if necessary. This worksheet includes addition, subtraction, multiplication and division of whole numbers, multiplication by a decimal and conversion of a fraction to a decimal. Identify the operation to be applied in each problem, if necessary.

Have students complete worksheet. Discuss their findings. Help them to realize both the quantity of hazardous waste collected and the vast amount still uncollected in Rhode Island homes.

EXTENSION
Have students survey the community to determine participation in Clean Up Days as well as what hazardous wastes are being stored.

NAME _____

SOLVE IT!

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT'S TOXIC CLEANUP DAYS, FALL 1984

SITE	NUMBER OF PARTICIPANTS	POISON OR PESTICIDE	WASTE OIL	PAINT	FLAMMABLE SOLVENT	NONFLAMMABLE SOLVENT	CORROSIVES
Cranston	169	81	78	65	85	3	12
Kingston	125	99	31	68	40	4	7
Cumberland	183	60	79	91	45	7	13
Portsmouth	124	44	55	52	23	7	14
Providence	182	62	52	90	60	3	16

1. DEM decided that a Toxic Cleanup Day was needed in Rhode Island. DEM's Division of Air and Hazardous Waste gets about a dozen calls per week concerning disposal. How many calls would you expect them to get in a year?

2. How many participants took part in the Toxic Cleanup Days all together?

3. Many Rhode Island residents turned in waste oil at the Toxic Cleanup Day because they were unaware of the recycling program. Seventy-eight people generated 750 gallons of oil at the Cranston site. How many gallons per person does that average?

4. Twelve sixteen-gallon drums of pesticide were filled at Cranston's Toxic Cleanup Day. How many gallons were collected?

5. The approximate cost of DEM's program was $10,000 per site. That money was used for disposal, transportation, equipment, and contractor costs. How much did the total program cost?

6. The Scituate Reservoir is an important resource for us to protect because at least 50% of Rhode Island's 945,000 residents depend on its surface water for drinking. How many people is this?

7. At least one-third of Rhode Island's population drinks from private wells. They are supplied by groundwater. Any hazardous wastes which leach into groundwater could contaminate wells. What % of Rhode Island residents depend on wells for drinking?

8. How many participants brought in flammable solvents?

9. Poisons and pesticides were brought in by 246 people. The largest number was handled at the Kingston site. How many poisons or pesticides were turned in at the other four sites?

10. Thirty-five per cent of Rhode Islanders change their own oil, but only 3% of those people recycle it. What percentage of Rhode Island residents are disposing of their oil in an environmentally hazardous (and illegal!) manner?

11. If 3% of the state's used motor oil amounts to 2 million gallons, then all of the do-it-yourselfers handle about ten times that amount. How much oil is being wasted by not being recycled?

Teacher's Page

SOLVE IT!

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT'S TOXIC CLEANUP DAYS, FALL, 1984

SITE	NUMBER OF PARTICIPANTS	POISON OR PESTICIDE	WASTE OIL	PAINT	FLAMMABLE SOLVENT	NONFLAMMABLE SOLVENT	CORROSIVES
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Providence	182	62	52	90	60	3	16

1. DEM decided that a Toxic Cleanup Day was needed in Rhode Island. DEM's Division of Air and Hazardous Waste gets about a dozen calls per week concerning disposal. How many calls would you expect them to get in a year? $12 \times 52 = 624$

2. How many participants took part in the Toxic Cleanup Days all together? $169 + 125 + 183 + 124 + 182 = 783$

3. Many Rhode Islanders turned in waste oil at the Toxic Cleanup Day because they were unaware of the recycling program. Seventy-eight people generated 750 gallons of oil at the Cranston site. How many gallons per person does that average? 750 divided by $78 = 9.6$

4. Twelve sixteen-gallon drums of pesticide were filled at Cranston's Toxic Cleanup Day. How many gallons were collected? $12 \times 16 = 192$

5. The approximate cost of DEM's program was $10,000 per site. That money was used for disposal, transportation, equipment, and contractor costs. How much did the total program cost? $5 \times \$10,000 = \$50,000$

6. The Scituate Reservoir is an important resource for us to protect because at least 50% of Rhode Island's 945,000 residents depend on its surface water for drinking. How many people is this? $945,000 \times .50 = 472,500$

7. At least one-third of Rhode Island's population drinks from private wells. They are supplied by groundwater. Any hazardous wastes which leach into groundwater could contaminate wells. What % of Rhode Islanders depend on wells for drinking? $\frac{1}{3} = 33\frac{1}{3}\%$

8. How many participants brought in flammable solvents? $85 + 40 + 45 + 23 + 60 = 253$

9. Poisons and pesticides were brought in by 246 people. The largest number was handled at the Kingston site. How many poisons or pesticides were turned in at the other four sites? $81 + 60 + 44 + 62 = 247$

10. Thirty-five per cent of Rhode Island residents change their own oil, but only 3% of those people recycle it. What percentage of Rhode Islanders are disposing of their oil in an environmentally hazardous (and illegal!) manner? $35\% - 3\% = 32\%$

11. If 3% of the state's used motor oil amounts to 2 million gallons, then all of the do-it-yourselfers handle about ten times that amount. How much oil is being wasted by not being recycled? $10 \times 2,000,000 = 20,000,000$ GALLONS

Lesson VII

USE IT UP OR USE IT OVER
Science /Art Activity

Students will be able to name two hazardous household substances and discuss methods of recycling them.

MATERIALS
Oil based paint, old paintbrush, 2 glass jars with covers, paint thinner or turpentine, Oil Recycling Stations List, small amount of motor oil, poster paper and art materials, old newspapers, clear plastic glass of water, small container of soil

SOURCE
SLEUTH

IMPLEMENTATION
Some hazardous substances can be recycled, lessening the amount that must be disposed. One recycling method can be demonstrated here. Display the can of oil-based paint. Ask students why they think oil-based paints may be preferred by consumers. (expected durability, personal preference, habit, etc.).Explain that latex (water-based) paints are becoming more readily used (resulting in less environmental problems). Paints have become safer over the years as the metal pigments (lead and cadmium) which were once common have been replaced by less toxic substances (after their health effects became known). Solvents, however, continue to be hazardous. A solvent is a substance which dissolves or cleans another substance – thus water is the solvent used to clean up after painting with latex paints. Oil-based paints, however, require a stronger solvent. Such solvents offer both acute and chronic hazards to the user. They are toxic to aquatic life (even in low concentrations) and hazardous in the air we breathe. Some are also extremely persistent in the environment, resisting ordinary breakdown. Thus a reduction in strong solvents used would have many net gains.

Dip the brush into the can of paint. Paint something if you wish, then clean the brush by wiping it on newspapers and dipping it into paint thinner you have placed in one of the jars. Then display the muddied jar of thinner to students. Ask them what they think you should do with the used thinner. If they advise disposal, discuss their recommendations for the best disposal method. Then advise them that the thinner can be recycled. Cap the jar, label it, and put it on a shelf OUT OF THE REACH OF CHILDREN. Leave it for a couple of weeks and eventually students will observe that the suspended material (old paint) will settle to the bottom of the jar. Students may wish to illustrate their observations on successive days. When the process is completed, pour the clear thinner into the other jar. It can be reused again and again, regardless of the colors used for painting. The remaining sludge should be dried out, capped and thrown away.

A second household substance which can easily be recycled is automotive oil. It is hazardous to the environment because of the organics and heavy metals (lead and arsenic) which are picked up in the combustion process. To demonstrate the persistance of motor oil, place a few droplets of the oil in the plastic glass of water. Have students observe the result and hypothesize about a removal or purification method. Tell them that a concentration of 1 part oil to a million parts water can still be detected through taste and odor. At that ratio, 1 quart of oil could seriously contaminate 250,000 gallons of water (more water than 30 people drink in a lifetime!).Explain that improper disposal of oil into storm drains will eventually lead the oil to Narragansett Bay or one of its feeder rivers. Toxic components can bioaccumulate in fish, thus jeopardizing R.I.'s fishing industry. The Federal Clean Water Act prohibits dumping gas or oil into water, storm drains or sewers, but many people still do it.

Next, place a few droplets of oil onto the soil. Observe, hypothesize again about removal and/or purification. Explain that this would be the dilemma if oil were either dumped directly onto the ground or sent to the landfill (as trash is compacted there, containers would break and the oil could leach into the ground). Lead students to recognize the threat this poses to groundwater supplies.

Explain to students that used automotive oil can be purified and reused, over and over again. Due to a 1980 law all lubricating oil sold in the U.S. is labeled with the statement "Don't Pollute – Conserve Resources: Return Used Oil to Collection Centers" (show can to students if possible). Yet it is estimated that only 3 – 5 % of Rhode Islanders do, in fact, recycle their oil. Discuss possible reasons for this (lack of information or awareness, laziness, carelessness, etc.). One way to combat this is to advertise. Thus, students should create posters informing the public of the local oil-recycling locations (check enclosed list). Posters could inform consumers of environmental dangers of improper waste disposal, extol the benefits of recycling oil, and/or merely announce the procedure and locations. Posters could be judged and/or distributed throughout the town.

VOCABULARY

recycle
solvent
persistent
breakdown
bioaccumulate
landfill
groundwater
leach

Lesson VIII

TOXIC FREE BINGO
Science

Students will become familiar with less toxic substitutes which can be used in place of common home and garden products.

MATERIALS
Toxic free bingo grids (one per child), "Safer Alternatives" information sheet (one per child), "Master Cards" – cut up and put into container, 10 markers (beans, papers, etc.) per student

SOURCE
TOXICS IN MY HOME? YOU BET!

OPTIONAL
Samples of safer alternatives

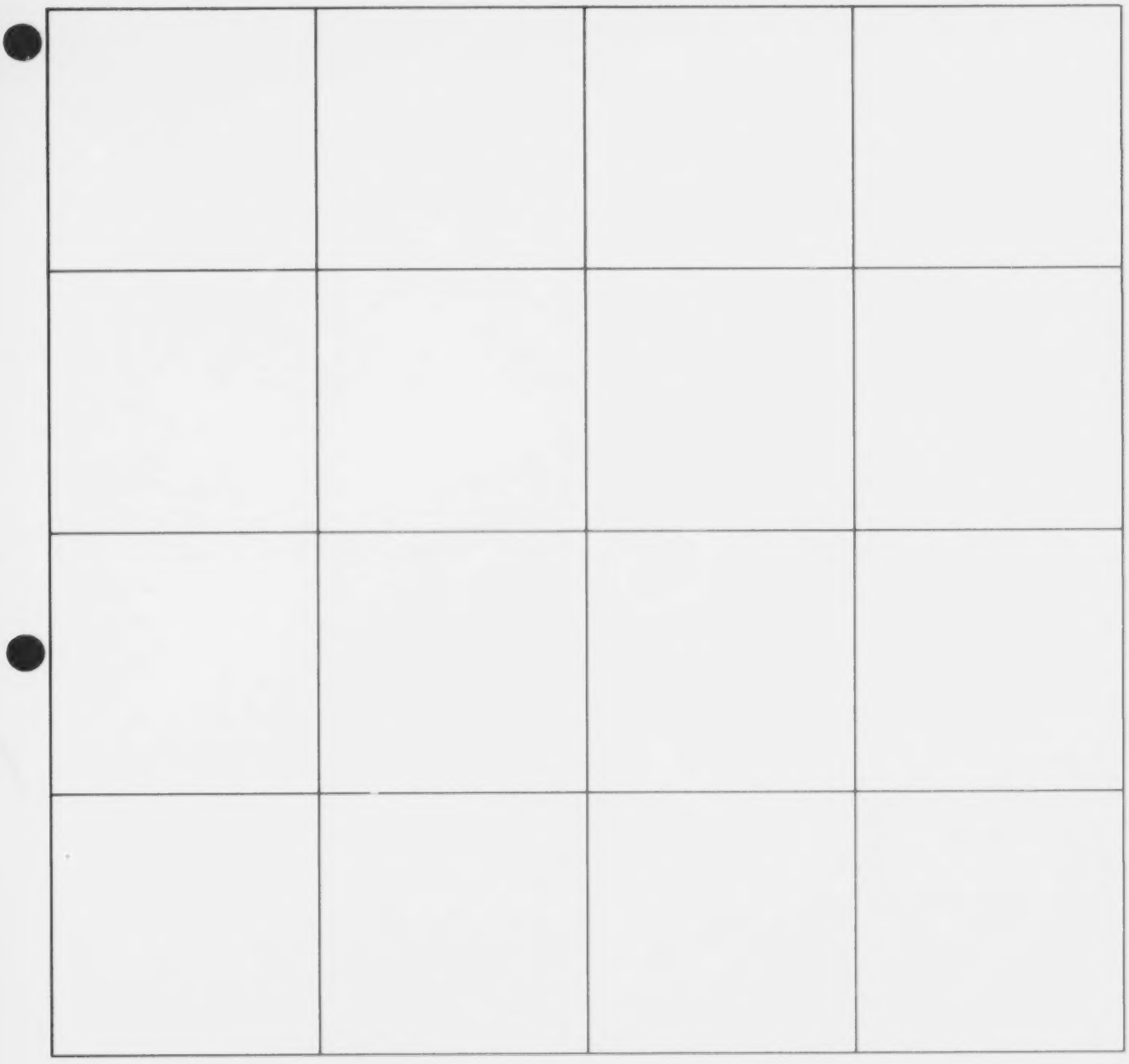
IMPLEMENTATION
Tell children that many potentially toxic substances are not only expensive but also unnecessary. Distribute "Safer Alternatives" information sheet and discuss. Ask if any entries are surprising or currently used in students' homes. Ask if children can add more to the list, and if they think their families would be willing to try some of the alternatives listed. Brainstorm ways in which safer alternatives could be made more convenient (keeping vinegar and water in pump spray bottle, etc.).

Distribute bingo grids to students. Each student should fill in grid by randomly writing one of the headings (listed on "Safer Alternatives" sheet) in each box. No word or phrase may be used more than once. Distribute markers. Teacher or student volunteer will draw a "Master Card" from the container. Students may cover a toxic product on their card which can be replaced by the substance called. (Example: teacher calls out "baking soda". Student may place a marker on oven cleaner, deodorizer, or scouring powder – one per turn!) Students may refer to "Safer Alternatives" sheet for help. Marking 4 in a row – horizontally, vertically, diagonally or the 4 corners wins the game. Students may switch cards for additional games.

EXTENSION
Have students create advertisements (including illustrations, slogans, jingles, etc.) extolling a "safer alternative".

Have students compare costs of common toxic products with an appropriate safer substitute.

TOXIC FREE BINGO



MASTER CARDS

Cut each rectangle and place in a container.

soap and water	pan with beer
lemon juice and vegetable oil	mayonnaise and soft cloth
pump-type sprayers	plunger
open windows for fresh air	plumber's snake
hot vinegar set in a dish	water based paint
baking soda	overturn clay pots
fresh cut flowers	compost
dried flower petals mixed with spices	screens
washing soda	cream of tartar
grated lemon rind	biodegradable soap
steel wool	vinegar and salt
mechanical mouse traps	brewers yeast
eucalyptus leaves	salt on spills

The following is a list of safer substitutes for some household toxics. Generally, the products can be bought in grocery stores.

AEROSOL SPRAYS
- Use pump-type sprays whenever possible to replace aerosols (e.g., hair sprays).
- Use fresh flowers or sachets of dried petals mixed with spices instead of room sprays.

ANT CONTROL
- Sprinkle cream of tartar in front of the ant's path. Ants will not cross over. Cream of tartar is a substance used in baking.

BUG SPRAY
- Place screens on windows and doors.
- Brewers yeast tablets taken daily give the skin a scent that mosquitos seem to avoid.

CHEMICAL FERTILIZERS
- Compost.

COPPER CLEANER
- Pour vinegar and salt over copper and rub.

DEODORIZERS/AIR FRESHENERS
- Open windows or use exhaust fans as a natural air freshener.
- A dish of hot vinegar can get rid of fish odors.
- Baking soda placed in the refrigerator reduces odor.
- Fresh cut flowers or dried flower petals and spices can add a nice scent to a room. You can also boil potpourri or cinnamon and cloves in water to produce a nice scent.

DETERGENTS (LAUNDRY & DISHWASHING)
- Replace detergents with soaps that are relatively "non-toxic" and biodegradeable. (To wash out residue from detergents, prewash in washing soda.)

DRAIN OPENERS
- Pour boiling water down the drain. Do this every week for preventative maintenance.
- Use a plumber's helper (plunger) or a plumber's snake.

FLEA REPELLANT
- Place eucalyptus seeds and leaves around the area where the animal sleeps.

FLOOR CLEANERS
- Use soap and water.
- Use washing soda and water.

FURNITURE POLISH

- Use a soft cloth and mayonnaise.
- Mix 1 part lemon juice and 2 parts vegetable oil.

GENERAL CLEANERS (ALL PURPOSE CLEANER)

- Mix 3 tablespoons washing soda in one quart of warm water.
- Use baking soda with a small amount of water.

GLASS AND WINDOW CLEANERS

- Use cornstarch and water.
- Mix ½ cup vinegar and one quart warm water. Wipe with newspapers.
- Use lemon juice and dry with a soft cloth.

OVEN CLEANERS

- Mix 3 tablespoons of washing soda with one quart of warm water.
- Place liners in oven to catch any drips during baking.
- Sprinkle salt on spills when they are warm and then scrub.
- Rub spills gently with steel wool.

PAINT

- Water based paints are less toxic than metal based. After using them, no solvent is necessary for "clean up".

RAT POISON

- Put a screen over drains.
- Use mechanical-snap mouse traps.

SCOURING POWDER

- Dip a damp cloth in baking soda and rub.
- Use steel wool.

SNAIL/SLUG BAIT

- Place a shallow pan with beer in the infested area.
- Overturn claypots. The snails will take shelter in them during the sunny days and they can be collected and removed.

Lesson IX

FIGHTING PESTS WITH PESTS
Language Arts/Art/Science

Students will become familiar with non-toxic solutions to combating common home and garden pests.

MATERIALS
Copies of *Fighting Pests with Pests*, Manilla paper 9 x 12 in., drawing materials

IMPLEMENTATION
Distribute, read and discuss *Fighting Pests with Pests*. Explain to students that they will create a class book, with each student investigating one pest for the book. Using the chart on pages 6-7 of the booklet, assign (or have students choose) a specific pest to be the topic of their page. Students should illustrate pests, showing them in their natural location. They may illustrate or write text citing natural controls. Bind book when completed, and place in school library.

ADDITONAL INFORMATION
Other alternatives for combating pests include:

attractants – light, sound and pheromones (sex odors) can be used to trap and/or confuse insects. In Hawaii, the oriental fruit fly, a major fruit pest, has been controlled through the use of attractants.

resistant crop varieties – the use of new breeds of plants that naturally resist insect attacks, fungi and disease. Different breeds of wheat have been developed that are more resistant to these problems.

farming methods control – planting before pests come or after they go; planting different crops in the same place so that pests of one crop cannot build up year to year, planting crops where the pests do not live. Boll weevils don't live in the West, thus cotton has successfully been grown there.

predators and disease – raised in laboratories, released where pests are. Lady beetles have been used to control cottony cushion scales, which are insects common on citrus trees in California.

sterilization of male pests – performed in labs through radiation or chemicals, males are then released to mate with no offspring resulting. Florida was ridded of the major livestock pest screw-worm flies in this manner.

Homeowners can practice pest and weed control with some of these methods: spray plants with nonchemical compounds – soap-and-water solution (3T soap per gallon of water) for aphids, mealybugs, mites and whiteflies; or spray with pyrethrum (a product of a type of chrysanthemum), to control caterpillars, beetles, aphids, mites, leafhoppers, thrips, moths and dozens of other fruit and vegetable pests.

Introduce other predatory bugs, such as soldier bugs, ladybugs, damsel bugs, pirate bugs, spiders, lacewings and gal midges to control unwanted pests.

Use bacterial pesticides such as *bacillus popilliae* for Japanese beetles and *B. thuringiensis* for many types of insect larvae; Interplant with pest-repellant plants – marigolds, coriander, thyme, yarrow, rue and tansy; dispose of garbage to avoid attracting ants; use flypaper and flyswatters instead of conventional sprays or make your own by grinding 1 garlic clove and 1 onion, adding 1 Tablespoon cayenne pepper and 1 quart water. Mix well, let steep 1 hour, then add 1 Tablespoon liquid soap. (Students may wish to compare the effectiveness of this compound vs. commercial sprays.) To control fleas on dogs and cats, bathe animals every 2 – 4 weeks with pet shampoos containing insect-repellant herbs such as rosemary, rue, eucalyptus, and citronella. For termites, ask exterminator to use organophosphates, such as chlorpyrifos.

Lesson X

THINK ABOUT IT!
Language Arts/Problem Solving

Students will analyze both sides of the issues raised within the unit, take a stand, and defend their position.

MATERIALS NEEDED
Student worksheet (one per student)

SOURCE
TOXICS IN MY HOME? YOU BET!

IMPLEMENTATION
Distribute worksheets to students. This activity may be conducted orally, as a class debate, or in writing. Encourage students to examine all sides of the issues. While it is hoped that working in this unit has influenced the student regarding his or her responsibility towards household hazardous wastes, there are no right answers in this exercise – simply problems to explore.

THINK ABOUT IT!

Choose one side of each of the following issues. Explain, orally or on a separate piece of paper, *why* you chose that position. Give as many reasons as you can to support your position.

1. (A) Health and safety data on any chemical should be available for any member of the public who cares to look at it.

   (B) Manufacturers should be allowed to keep health and safety data secret.

2. (A) We should try to limit our consumption of synthetic products – for example, nylon and plastic – that tend to generate toxic or hazardous wastes during their manufacture.

   (B) We should take full advantage of the benefits of modern technology and enjoy all the products, hoping that a safe means for disposal of all toxic wastes will be developed at some point in the future.

3. (A) The federal government should be able to determine where hazardous waste dumps should be located.

   (B) Local communities should be able to determine whether or not they want a hazardous waste disposal facility in their community.

4. (A) Household quantities of wastes are small enough that they should not be regulated like industrial wastes.

   (B) Household quantities of toxic substances should be regulated just as industrial quantities are. The same chemicals used by households are used by industries who manufacture or use the product.

5. (A) Chemical companies should pay for health and safety tests of their chemicals.

   (B) Health and safety tests should be financed by public funds.

Students will answer questions of increasing difficulty based on their knowledge of household hazardous waste. Draw the following game board on the chalkboard. Divide the class into two teams. Explain that one person from each team chooses and answers a question relating to the information they have learned in this unit. The teams alternate in answering a question, with each team member responsible for answering one question. Students may choose questions from anywhere on the board – they do not have to go in order. The 10 point questions are easier than the 50 point questions.

A student should choose a question by topic and points (example: disposal for 30). The teacher should read the question aloud. If the student answers correctly, the teacher crosses out those points from the game board and awards them to the team who answered correctly. If the student answers incorrectly, the points remain on the board and it becomes the other team's turn. Play continues until all questions are used. Team with the most points wins.

Teacher may add questions to any category to lengthen the game.

SOURCE
Adapted from "TOXICS IN MY HOME? YOU BET!"

DAILY LIFE	HEALTH EFFECTS	DISPOSAL	SAFER SUBSTITUTES	ENVIRONMENTAL EFFECTS
10	10	10	10	10
20	20	20	20	20
30	30	30	30	30
40	40	40	40	40
50	50	50	50	50

DAILY LIFE

10 Name three toxic products often found in our homes.
20 Name three locations within the home where toxic products can often be found.
30 Name three ways to make your home safer from accidental poisoning by a toxic substance.
40 Name a common accident that involves a toxic product and tell how it could be prevented.
50 Tell why you think *toxics* may be helpful or harmful to have around. Why do we or don't we need these products in our homes?

HEALTH EFFECTS

10 True or false: eating a toxic product is the only way it can cause bodily harm.
20 Name three ways toxic substances can get into your body.
30 Tell how you can protect yourself when using toxic products which can be absorbed through the skin.
40 Explain the difference between chronic and acute effects.
50 Name at least three ways to avoid unsafe situations involving toxic products.

DISPOSAL

10 Name three common ways of disposing of toxic household substances safely.
20 When a toxic product is dumped down a sink or toilet, where could it end up?
30 People often dump toxic products on the ground. How can that affect us?
40 Explain what a Toxic Cleanup Day is.
50 If toxic wastes create a disposal problem, what advice would you give to people who buy and use such products?

SAFER SUBSTITUTES

10 Name two toxic products and their safer substitutes.
20 Name two uses for baking soda as a cleaning agent.
30 Name three advantages of using safer substitutes.
40 Name three ways to get rid of pests without using chemical pesticides.
50 You're cooking a fish dinner and the pan flips over. Oil goes all over the floor – what a mess! You decide to cook the fish in the oven and find that the oven is smoking because of previous food spills. You give up and throw the remaining fish and oil down the garbage disposal in the sink, thus clogging the drain. Using only safe substitutes, how would you get rid of the fish odor, clean the oven, clean the floor and open the drain?

ENVIRONMENTAL EFFECTS

10 Explain how the use of pesticides can affect air, land and water supplies.
20 Explain how pesticides can work their way up the food chain.
30 Explain the dangers of disposing of household hazardous wastes in a septic tank.
40 Explain why DDT is no longer available for use.
50 The Federal Insecticide, Fungicide and Rodenticide Act was passed in 1972, "grandfathering" all prior pesticides. What does this mean and what problems could this create?

HOUSEHOLD HAZARDOUS WASTES

VOCABULARY

absorption – the act or process of soaking in or up, the condition of being absorbed

acute – having a sudden onset and short term, as in an acute illness

aquifer – an underground geological formation in which the cracks in rock, sand or gravel are filled with water

bio-accumulation – concentration of chemicals in the fatty tissues of living organisms up the food chain, over time

bioconcentration – build-up of chemicals in the fatty tissue of living organisms

breakdown – disintegration or decomposition into component parts or elements

carcinogen – a cancer causing agent

central nervous system – portion of the nervous system composed of the brain and spinal cord

chronic – of long duration

corrosive – capable of wearing away by chemical action

degradation – a general lowering of the earth's surface by erosion or transportation in running water

food chain – a succession of organisms in a feeding chain in which food energy is transferred from one organism to another as each consumes a lower member and is, in turn, preyed upon by a higher member

ingestion – to take in by, or as if by, swallowing

inhalation – to take in by breathing

irritation – irritability, soreness, roughness or inflammation of a bodily part

isolate – to separate from another substance so as to obtain in a pure state

landfill – a site for the burial and decomposition of solidwaste

leachate – liquid that has percolated through solid waste and has extracted, dissolved or suspended materials in it. This liquid may contaminate ground or surface water

motive – something, like a need or desire, that causes a person to act

mutagen – an agent, such as a radioactive element or ultra-violet light, that causes biological mutation

persistent – continuing to exist in spite of interference or treatment

poison – a substance that through chemical action kills or injures an organism

potential – something that can develop or become actual

septic tank – a tank in which the solid matter of continuously flowing sewage is disintegrated by bacteria

sewer – man-made, underground system to carry off sewage or rain water

solvent – a liquid capable of dissolving another substance

teratogen – an agent which causes fetal malformations or monstrosities

toxic – poisonous

ventilate – to expose to fresh air, to cause fresh air to circulate through

waste water – water that has been used (in a manufacturing process or in your home) and requires purification before it can be used again

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OSCAR'S OPTIONS
BOOK II

A Supplementary Environmental Education Curriculum

By Carole O. Bell and Martha M. Schwartz

100% Recycled Paper

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THE PROBLEM OF WASTE DISPOSAL

Introduction

Only 15 years ago, the state of Rhode Island had 44 legal sites for disposal of solid waste, most of which were open, burning dumps. Increased public concern about air pollution and passage of the Clean Air Amendments in the early 1970s forced a ban on open burning, and communities turned to sanitary landfills for burial of their ever-increasing quantities of solid waste. These small, local landfills gradually filled and closed, causing city and town leaders to look outside their borders for disposal options. By the late 1970s, 19 of Rhode Island's 39 communities transported their refuse to one large, regional disposal facility – the Central Landfill in Johnston.

The Solid Waste Management Corporation (SWMC) was established by the General Assembly in 1974 as a quasi-governmental agency responsible for developing environmentally sound methods of waste disposal for the State of Rhode Island. In order to gain greater control over the state's solid waste disposal, the Solid Waste Management Corporation purchased the Central Landfill from the Sylvestri brothers in December, 1980. The Sylvestri Landfill had begun operations in 1955, accepting all types of waste, including liquid hazardous materials. Subsequent regulations forced the Sylvestris to separate hazardous materials from the other waste and eventually to stop accepting hazardous materials. At this point, the Landfill was sold to SWMC.

The Landfill was intended to serve Rhode Island's disposal needs until an integrated waste disposal system could be designed and implemented. By the middle of the 1980s, the annual estimated amount of municipal and commercial waste accepted at the Central Landfill was 645,000 tons. Municipal waste from Rhode Island households accounted for 345,000 tons per year, or 75% of the state's estimated municipal output of 450,000 tons. Commercial solid waste (generated by business and industry) was delivered to the Central Landfill at an estimated annual rate of 300,000 tons. This represents 90% of the estimated 340,000 tons of refuse produced by the business community each year. In addition to solid waste from home and industry, the Central Landfill receives about 84,000 tons of sludge from sewage treatment plants annually.

The Central Landfill also provides a disposal location for about 10,000 tons of non-hazardous liquid waste per year. This disposal of liquid waste is now closely monitored by the Department of Environmental Management and the Solid Waste Management Corporation. However, since hazardous liquid materials were deposited prior to SWMC ownership of the facility, the Central Landfill has been designated by the EPA as a Superfund cleanup site

Nine Rhode Island cities and towns – Burrillville, North Providence, Bristol, Charlestown, Richmond, Tiverton, Westerly and New Shoreham (Block Island) – still operate their own landfills, accepting waste *only* from within the community (as of 1987). Little Compton, directly adjacent to Tiverton, must transport its refuse to the Central Landfill. The Aquidneck Island communities had been directing their waste to a nearby, out-of-state facility for several years. Unfortunately, a contract dispute has forced them to send all of their waste to Johnston since early in 1986. The estimated life expectancy of local landfills is five to ten years. Many of the sites have already been expanded to accommodate the anticipated increase in waste in the upcoming decade.

Not a single major landfill has been sited in the northeastern United States in the last ten years. Existing landfill facilities are recognized as a major source of groundwater contamination and continued expansion is not an option. No one wants a landfill as a neighbor, not only because of the problems of traffic, noise, dust and odors, but also because it has been clearly demonstrated that land disposal poses long-term environmental threats to water resources. Thus, our options are limited, and the State of Rhode Island has been forced to seek innovative, alternative techniques for solid waste management.

During the 1986 session, the Rhode Island legislature passed and Governor Edward DiPrete signed into law a comprehensive solid waste management bill (SO849-sub B). The bill requires source separation of solid waste into recyclable and non-recyclable components prior to disposal in any state-owned facility. Rhode Island residents will be required to separate their household waste into three categories – newspaper, mixed recyclables and other waste.

The Department of Environmental Management defines which materials will be recycled. Recyclables include aluminum, glass, tin cans, beverage plastics and newspaper. This definition may be altered due to economic, technological or environmental factors. Recyclable materials are taken to a Materials Recovery Facility just outside the Central Landfill, where they are tipped at no charge, sorted, processed and marketed. The bill mandates that at least 15% of the waste stream be recovered.

In addition, the bill allows the Solid Waste Management Corporation to construct three mass burn resource recovery facilities which will burn waste and produce steam generated electricity. The first RRF will be built at the Central Landfill, the second at Quonset Point/Davisville in North Kingstown and the third at a site in northern Rhode Island.

The enormity of Rhode Island's solid waste disposal problems demanded a comprehensive solution which both reduced the waste stream and provided an alternative to land disposal. As a result of the combination of recycling and resource recovery described above, the Central Landfill will receive only 600 tons of ash each day. Rhode Island cannot dispose of all of its waste without a landfill, but it is clearly possible to substantially reduce the amount of waste buried and thus extend the life expectancy of the Central Landfill.

OSCAR'S OPTIONS
UNIT IV
LANDFILLS

LANDFILLS

OBJECTIVES

1. Students will understand the sources, content and magnitude of the solid waste problem.

2. Students will be introduced to the history of trash solutions and will be able to distinguish between a dump and a landfill.

3. Students will understand the process of decomposition in a landfill. Students will learn which items are degradable and which will not deteriorate over time.

4. Students will compare the biological activity in three different waste disposal systems and be able to identify which conditions are conducive to decomposition.

5. Students will conduct experiments comparing the water-holding capacity of various soils to determine the importance of soil studies prior to the siting of landfills.

6. Students will read background information about the Rhode Island Central Landfill and outline the material.

7. Students will read a table of figures on solid waste production and disposal sites and apply math skills (addition, subtraction, multiplication and division of whole numbers) to data on table.

8. Students will become familiar with both past and present landfills in Rhode Island and will locate them on a state map.

9. Students will apply their knowledge of solid waste problems to determine an appropriate use for a landfill site upon completion of the landfill operation.

LANDFILLS

ACTIVITIES

I.	Trash – A Big Problem	Introduction and Social Studies
II.	Looking At Landfills	Reading and Creative Thinking Activity
III.	Mini Landfill	Science Activity
IV.	Even Trash Needs a Breath of Fresh Air!	Science Activity
V.	Soil – Does It Make A Difference?	Science Activity
VI.	The Largest Landfill	Reading Activity
VII.	So How Much Is There?	Math Activity
VIII.	A Landfill in *My* Town?	Reading and Map Activity
IX.	Life After Landfills	Reading and Creative Thinking Activity

LANDFILLS

TEACHER INFORMATION

These lessons were written with grades 4 – 8 in mind. All student materials are written at a 6th grade reading level. The lessons within the unit are arranged sequentially, but individual lessons may be taught or deleted as best suits you and your class.

POSSIBLE IMPLEMENTATION OF LANDFILLS UNIT

Monday	I. Introduction and Social Studies Activity	40 min.
Tuesday	II. Reading and Creative Thinking Activity	40 min.
	Follow-up Activity (Homework)	15 min.
Wednesday	III. Science Activity	30 min.
Thursday	IV. Science Activity	30 min.
Friday	V. Science Activity	30 min.
Monday	VI. Reading Activity	45 min.
	VII. Math (Homework)	45 min.
Tuesday	VIII. Reading and Map Activity	45 min.
	IX. Reading and Science Activity (Homework)	20 min.
Wednesday	X. Reading and Creative Thinking	20 min.

Lesson I

TRASH-A BIG PROBLEM

Social Studies Activity

Students will understand the sources, content and magnitude of the solid waste problem.

MATERIALS NEEDED

Student worksheet (one per student)

IMPLEMENTATION

Distribute "What Do *You* Know About Trash?" and allow time for completion. Use this as an introduction to the topic of solid waste. Share answers with students and have them mark the correct answers on their papers to enable them to share the information with their families.

Further their thinking by asking the extension questions accompanying the answers. Through discussion, share the reasons and implications behind each correct answer. Help students to recognize the underlying causes of the trash explosion (rising population, increased packaging, greater industry, higher personal income etc.).

EXTENSION

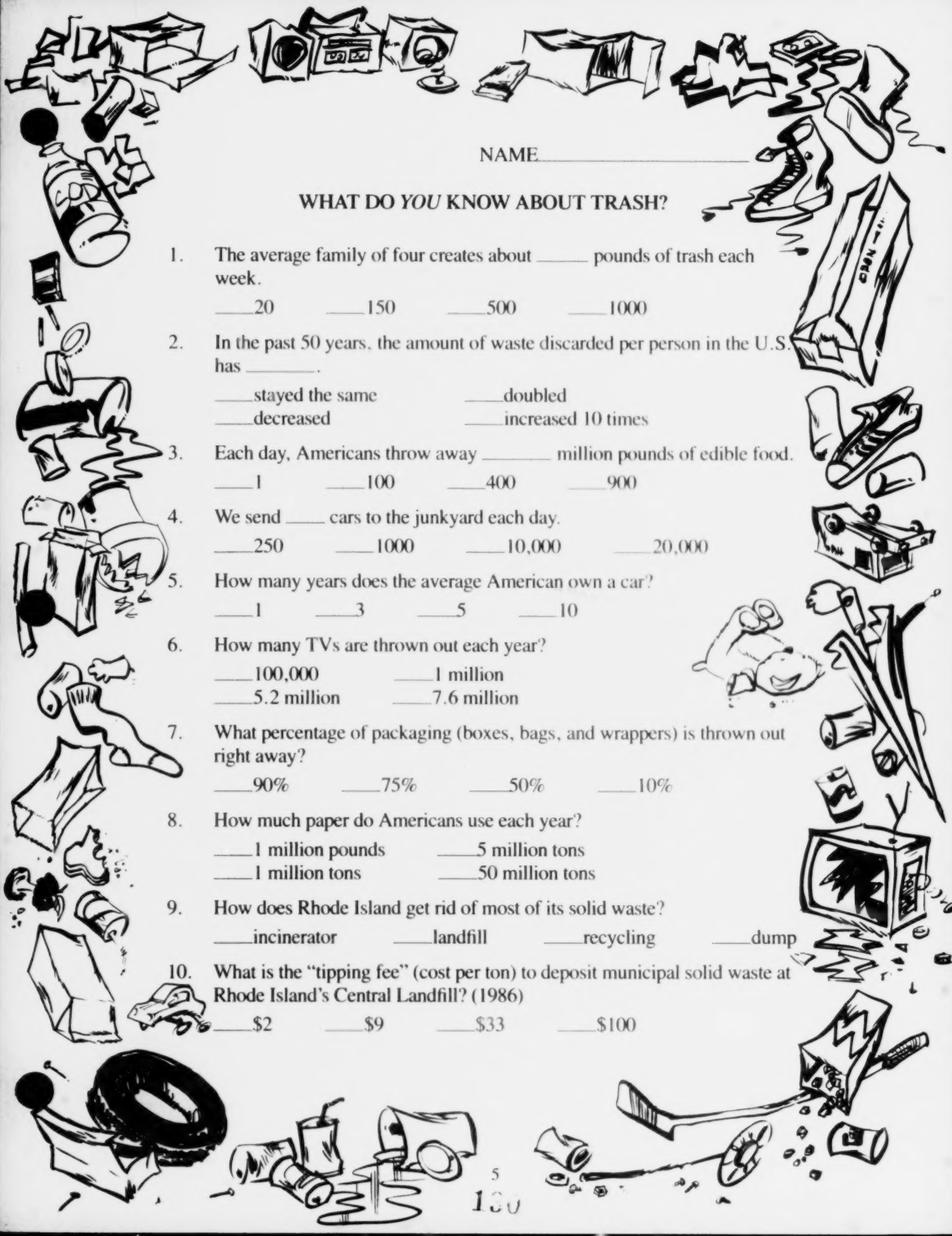
Create a Class Trash Book – each student is assigned a letter of the alphabet to create one page of the book. Each page should contain lists and illustrations of waste items beginning with that letter.

Have students create a bulletin board or posters displaying collages in the form of trash cans. Instruct them to include pictures representing each category of solid waste using the following figures: the family trash can typically includes 16% yard waste, 6% plastic, 15% food waste, 10% metal, 10% glass, 30% paper and 13% miscellaneous rubbish.

Have students conduct a survey concerning planned obsolescence, consumerism and the American lifestyle by creating questions to determine either the age or number of several common household items found in their homes. Combine and average answers to create an overall picture.

VOCABULARY

solid waste	trash	dump
garbage	compost	recycle
incinerator	tipping fee	landfill
obsolescence		



NAME_____

WHAT DO *YOU* KNOW ABOUT TRASH?

1. The average family of four creates about _____ pounds of trash each week.

   ____20 ____150 ____500 ____1000

2. In the past 50 years, the amount of waste discarded per person in the U.S. has _____.

   ____stayed the same ____doubled
   ____decreased ____increased 10 times

3. Each day, Americans throw away _____ million pounds of edible food.

   ____1 ____100 ____400 ____900

4. We send ____ cars to the junkyard each day.

   ____250 ____1000 ____10,000 ____20,000

5. How many years does the average American own a car?

   ____1 ____3 ____5 ____10

6. How many TVs are thrown out each year?

   ____100,000 ____1 million
   ____5.2 million ____7.6 million

7. What percentage of packaging (boxes, bags, and wrappers) is thrown out right away?

   ____90% ____75% ____50% ____10%

8. How much paper do Americans use each year?

   ____1 million pounds ____5 million tons
   ____1 million tons ____50 million tons

9. How does Rhode Island get rid of most of its solid waste?

   ____incinerator ____landfill ____recycling ____dump

10. What is the "tipping fee" (cost per ton) to deposit municipal solid waste at Rhode Island's Central Landfill? (1986)

    ____$2 ____$9 ____$33 ____$100

Teacher's Page

WHAT DO *YOU* KNOW ABOUT TRASH?

1. The average family of four creates about 150 pounds of trash each week.

   *If a family of four creates 150 pounds of waste weekly, how much would that amount to in a year? (150 x 52 = 7800 pounds) Help your class to envision almost 4 tons of waste by comparing it to: 9 horses (950 lbs. each), 4 1/2 cows (1800 lbs. each), 5 pilot whales (1500 lbs. each), or a WW II German fighter plane (7700 lbs.).

2. In the past fifty years, the amount of waste discarded per person in the U.S. has *doubled*.

   *What reasons can you think of to explain this increase in waste?
   –increased packaging
   –increase in items designed for one use only
   –increased industry
   –higher personal income resulting in greater purchasing power

   Discuss with students the fact that Americans generate more solid waste per person than do people in any other country. We throw away 3 kg. per person daily. Yet Australians discard 0.8 kg./person each day, and people in India throw away only 0.2 kg./person per day! Students should contemplate the causes: different buying habits, different ways of life, the fact that Australia and India are much less developed than the United States.

3. Each day, Americans throw away 400 million pounds of edible food.

   *Mention waste in the school cafeteria and the food discarded at home. What else could be done with this food?
   –it could be composted or used as animal fodder
   –smaller portions could be served initially to cut down on waste
   –usable surplus could be donated to foodbanks or organizations which feed the needy.

   The United Nations estimates that 460 million people do not receive an adequate amount of the right kinds of food. The diet of these people is frequently lacking in:
   –calories (fewer than 2200 calories per person each day is the norm throughout China, India, and much of Africa. We consume more than 3300 calories per person each day in the U.S.)
   –protein (less than 60 grams per day in the above named places compared to more than 90 grams each day in the U.S.)
   –needed micronutrients.

   Malnutrition exists not because we don't produce enough food, but rather because of unequal distribution of what is grown. The most affluent third of the world's population eats well over half the food produced. (See OSCAR'S OPTIONS, Book I, Natural Resources, lesson 4.)

4. We send 20,000 cars to the junkyard each day.
*What could be done with the cars instead of just throwing them away?
–We could reuse the metal, batteries, tires and other parts for auto repair and body work.
–We can recycle the tires, batteries and plastic interior shell.
Twenty thousand cars, placed end to end, would result in a line over 50 miles long, the full length of the state of Rhode Island. In the course of a year, Americans discard over seven million cars — enough to stretch 17,500 miles (two-thirds of the distance around the earth at the equator)!

5. How many years does the average American own a car? 5

*Why do you think we trade cars in so frequently?
(to keep up profits, manufacturers try to convince drivers to purchase new automobiles by changing the styles, updating options, and planning obsolescence. Only certain models are expected to "last" past the 100,000 mile mark.)

6. How many TVs are thrown out each year? 7.6 million

*If a television set will last 10 to 15 years, why do you think so many are thrown away? (product variety, improvement over time – from tubes to printed circuits, from black and white to color, a variety of sizes from micro to widescreen, a variety of fashion colors) Again, the manufacturers convince us that a new (or another) TV is needed in our lives, even if the old one continues to function perfectly well.

7. What percentage of packaging (boxes, bags, and wrappers) is thrown out right after purchase? 90%

*Can you think of ways to reduce this percentage to reduce our litter and solid waste problem and to save natural resources as well? (Use reusable packaging – paper bags, straw baskets; boycott certain items which carry excess packaging and alert manufacturers to your dissatisfaction.) Fast food packaging is one of the largest litter items, and most of it (styrofoam and plastic lids) is not biodegradable or recyclable.
Therefore, although the packaging is in use for a very few minutes, it will persist in our landfills for literally thousands of years. Discuss with students how this practice might be changed. (see also OSCAR'S OPTIONS, Book I, Litter Unit)

8. How much paper do Americans use each year? 50 million tons

*What are ten things we use paper for on a daily basis? Can you think of ways to reduce the amount of paper we use? (schoolwork, newspaper, cereal boxes, paper bags, stationery, magazines, tissues, napkins, paper towels etc.) Assist students in finding ways to change their behaviors and lessen consumption by substituting materials which can be used repeatedly whenever possible.) Explain to students that it takes 10,000 trees to print the Sunday *New York Times* each week – and that most papers are discarded the next day!

9. How does Rhode Island get rid of most of its solid waste? landfill

*Ask students if they know the meaning of the other terms – they will be discussed at length throughout this volume.

10. What is the "tipping fee" (cost per ton) to deposit municipal solid waste at Rhode Island's Central Landfill as of 1986? $9

*Do students feel that this is too much, too little, or just right? Explain that, in 1987, citizens in Fall River paid $60 per ton, Bostonians paid $65 – $90/ton, and New York City residents paid $90 – $150/ton to place trash in a landfill. Our rate is so low because it is subsidized by the state. The state owns the landfill and, therefore, taxpayers help to support it both directly and indirectly. Because of this system, we all pay the same amount for waste disposal, regardless of how much trash we personally create. Unfortunately, this amount may not be sufficient to protect us adequately from the possible loss of valuable drinking water supplies through contamination. Also, perhaps because trash is so inexpensive to dispose of, Rhode Islanders are too casual about the amount of waste we create.

Lesson II

LOOKING AT LANDFILLS

Reading/Creative Thinking Activity

Students will be introduced to the history of trash solutions and will be able to distinguish between a dump and a landfill.

MATERIALS NEEDED

student reading sheet (one per student), landfill transparency, overhead projector.

BACKGROUND

> Although land is too valuable a natural resource to be needlessly polluted by discarded materials, most solid waste is disposed of on land in open dumps and sanitary landfills. . . . Alternatives to existing methods of land disposal must be developed since many of the cities in the United States will be running out of suitable solid waste disposal sites within five years, unless immediate action is taken.
> *Resource Conservation & Recovery Act, 1976*

In the early 1970s, the federal government passed laws prohibiting open dumping. Guidelines were established to ensure that the sanitary landfills which replaced open dumps would operate with long-range planning and careful monitoring of groundwater supplies. Yet, even as the United States upgraded its trash disposal methods, future problems could be anticipated.

By the mid 1980s, many landfills across the country were in trouble. Rhode Island's Central Landfill, the largest landfill in New England, is at critical capacity. At our current rate of disposal, it will reach its legal limits by the mid 1990s. The problem, then, is choosing and implementing alternative disposal methods. To reduce the waste stream and extend the life of local landfills, the State of Rhode Island has selected three methods: mandatory recycling, a materials recovery facility (MRF) and resource recovery facilities (RRF). In addition, the state will undertake efforts to reduce the amount of waste entering the system through consumer education.

IMPLEMENTATION

Distribute worksheet and instruct students to read it. Display the landfill transparency to enable students to visualize the process. Students should realize that landfills:

- –are less expensive to initiate and maintain than resource recovery facilities
- –accept all types of waste (although hazardous materials must be contained to protect the groundwater)
- –require no minimum or maximum amounts of waste per day to operate
- –require only one waste disposal technique
- –may yield recreation land and methane when filled

These advantages have made them good short-term solutions to the waste problem. Yet the long-term environmental problems force us now to look for better solutions. Encourage students to explore/brainstorm other options for waste disposal and to recognize the potential problems inherent in any such solution.

Possible answers and the resulting consequences include:

- –burial at sea – would result in pollution of ocean, possibly killing off many forms of sea life, and would require large amounts of fossil fuel for transport.
- –sending trash off into space – would result in pollution of space; huge amounts of fuel and money would be needed to support this.
- –burning – air pollution and ash disposal are two resulting problems; citizen opposition to the siting of incineration facilities is another factor.

EXTENSION

Distribute word search for follow-up activity or as a homework assignment.

VOCABULARY

dump
trash
transfer station
refuse
topsoil
hazardous waste
resource recovery
leach
landfill
dispose
contaminants
decay
ground water
compost
recycling

TRASH – WHAT'S THE PROBLEM?

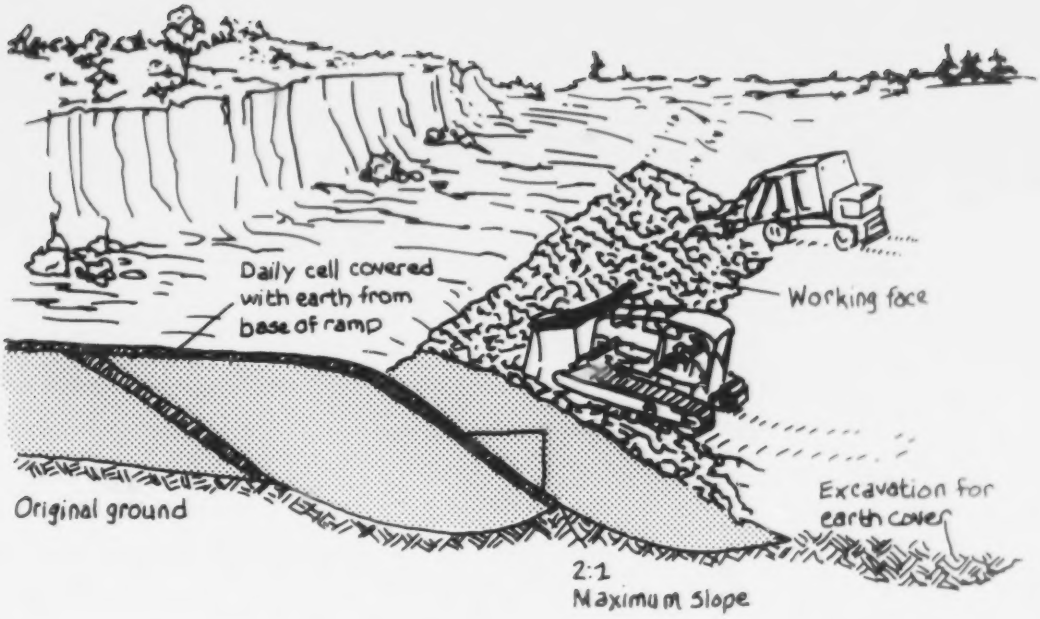
Suppose that the next time you are asked to take out the garbage, you carry it to a pile in the corner of the yard. Imagine tomorrow's garbage tossed on top of the pile. Try to picture what would happen in a week, a month or even a year. Suppose you had to dispose of your broken television or rusty car on that same pile. You wouldn't have much of a yard left. You'd have a dump!

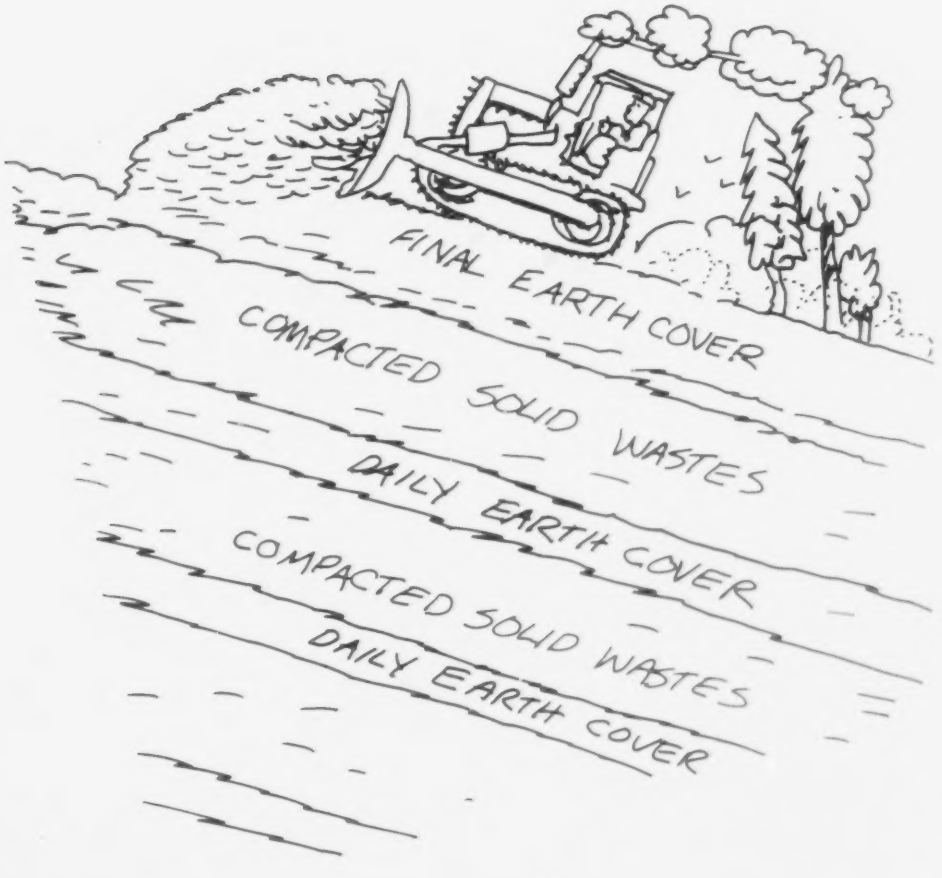
Many years ago, people chose a place on their land for disposal of items they could no longer use. A muck heap or home dump took care of all of the waste. Later, more people moved in, homes were closer together, and consumers threw away more and more. Soon, home dumps didn't make sense anymore.

Towns and cities began to pick up the waste and haul it in trucks to one big dump. Some communities were so far away that their garbage trucks had to stop at a transfer station. There, trash from several trucks was packed into one big truck which then traveled to the dump. This kept the backyards clean, but it made a huge mess at the dump. Horrible smells, rodents, insects and just sheer ugliness resulted. Burning the refuse polluted the air. Rain washed harmful contaminants into the ground. Town dumps were not a good answer to the growing trash problem.

Landfills are the present trash solution. Trucks bring the waste to the landfill. Each truck is weighed and the town pays for each ton of waste. Then the truck drives to the working face of the landfill and dumps its load of garbage. The garbage is spread several feet deep, then packed down by heavy machines. Each day, the open site is covered with six inches of clean soil. This speeds decay and protects us from health hazards. A huge amount of valuable topsoil is used. Landfill machinery makes noise and dust. The steady stream of garbage trucks may cause problems for landfill neighbors. In spite of careful planning, some wastes may ruin our water supply. To be sure that hazardous wastes do not leach into the groundwater, we need special, sealed landfills.

Landfills alone can't deal with the five pounds of waste each person in the United States creates daily. We must reduce the amount of waste we produce. We'll need new methods like recycling and resource recovery to help. The final solution to the trash problem has still not been found.


Daily cell covered with earth from base of ramp
Working face
Original ground
Excavation for earth cover
2:1
Maximum Slope


FINAL EARTH COVER
COMPACTED SOLID WASTES
DAILY EARTH COVER
COMPACTED SOLID WASTES
DAILY EARTH COVER

NAME_____

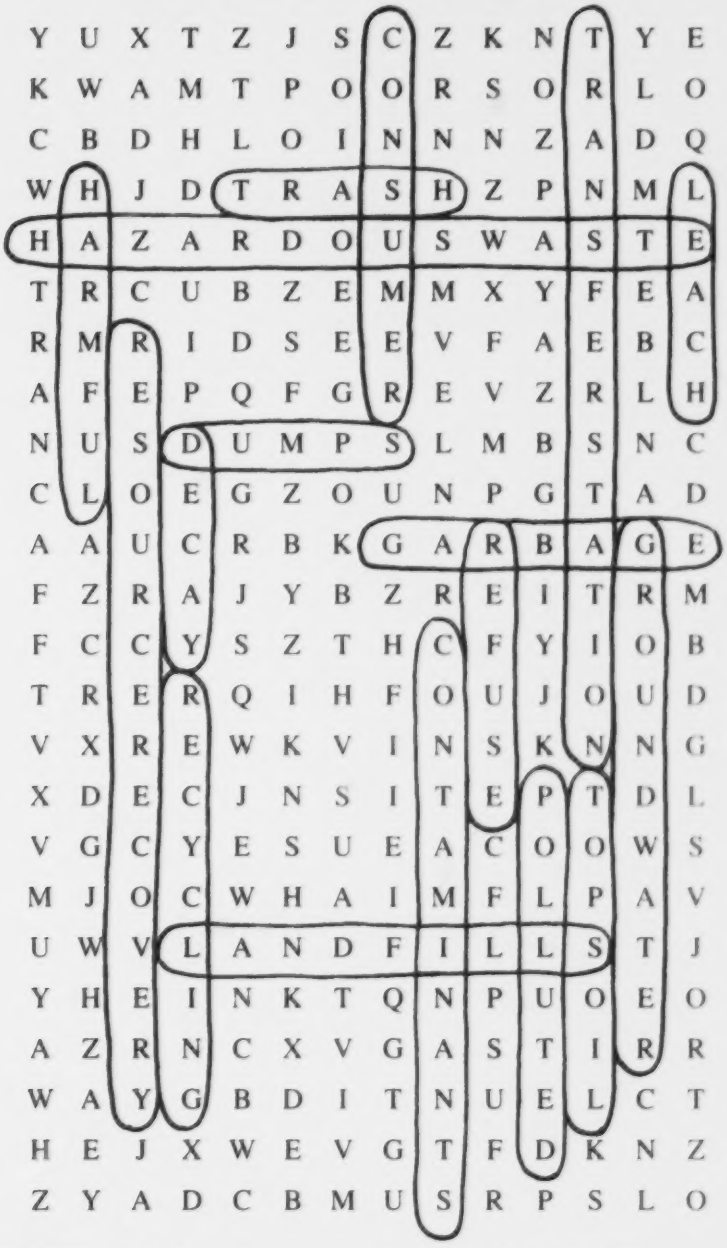
WORDSEARCH...BURIED TRASH

Eighteen important words from "Trash – What's the Problem?" are hidden in this wordsearch. Find and circle 12 vertical and 5 horizontal words. List them on the back of the paper. Be sure you know what they mean!

Y U X T Z J S C Z K N T Y E
K W A M T P O O R S O R L O
C B D H L O I N N N Z A D Q
W H J D T R A S H Z P N M L
H A Z A R D O U S W A S T E
T R C U B Z E M M X Y F E A
R M R I D S E E V F A E B C
A F E P Q F G R E V Z R L H
N U S D U M P S L M B S N C
C L O E G Z O U N P G T A D
A A U C R B K G A R B A G E
F Z R A J Y B Z R E I T R M
F C C Y S Z T H C F Y I O B
T R E R Q I H F O U J O U D
V X R E W K V I N S K N N G
X D E C J N S I T E P T D L
V G C Y E S U E A C O O W S
M J O C W H A I M F L P A V
U W V L A N D F I L L S T J
Y H E I N K T Q N P U O E O
A Z R N C X V G A S T I R R
W A Y G B D I T N U E L C T
H E J X W E V G T F D K N Z
Z Y A D C B M U S R P S L O

Teacher's Page

WORDSEARCH...BURIED TRASH



HORIZONTAL WORDS: trash, hazardous waste, dumps, garbage, landfill.

VERTICAL WORDS: harmful, resource recovery, decay, recycling, contaminants, refuse, polluted, topsoil, transfer station, leach, groundwater.

Lesson III

MINI LANDFILL

Science Activity

Students will understand the process of decomposition in a landfill. Students will learn which items are biodegradable and which will not deteriorate over time.

MATERIALS NEEDED

Two identical pieces of each of the following: food scraps, newspaper, cardboard, glass, cloth, aluminum foil, plastics, copper wire etc., a cardboard shoe box, a piece of foil or plastic to line the box, toothpicks, string, masking tape, index cards or small cardboard squares, water, student worksheet (one per student)

IMPLEMENTATION

Explain to students that landfills not only hold our waste, but that the process of covering the garbage with soil actually contributes to breaking it down into smaller and smaller pieces. But only certain materials will decay. Building a mini landfill provides an opportunity for students to hypothesize about what kinds of materials will break down over time and then determine the accuracy of their predictions.

Have students construct a mini landfill by lining the shoe box with aluminum foil or plastic. Fill the box half-full with earth. (NOTE – DO NOT USE POTTING SOIL – it has been sterilized and does not contain the microorganisms which are essential to the process!) Bury two identical rows of waste, marking the location of each item with cardboard labels on string or toothpicks. Students may prepare one mini-landfill as a class project; several, in small groups; or individual projects.

On the worksheet, note the date and items placed into the landfill. Add water to moisten the soil, then place the mini landfill in a sunny spot. Water the landfill regularly, keeping the soil moist, but not wet. Wait 10 days before continuing with the second phase of the project.

After 10 days, carefully remove the waste items from one row of the landfill and examine them. A magnifying glass may be helpful at this point. Individually, or as a class, answer the questions on the student worksheet.

Wait 10 more days and repeat for the second row of waste materials. Mini landfill discussion questions may be discussed orally or prepared individually for comparative purposes.

EXTENSION

Choose an area of the ground outside which is shady yet near small plants or grasses, or encourage students to conduct this experiment at home and report results to the class. Impale an apple onto a stick so that it cannot be carried away by animals. Observe it day by day and keep a record of what happens. This may be done in illustrative form. Keep track of: the first signs that something has been eating it, the first break in the skin, the first indication of decay odors, the appearance of insects or worms and where they come from, the appearance of molds or fungi. The record will indicate how many days it takes the apple to almost disappear and how many different agents worked on the cleanup job.

VOCABULARY

biodegradable
leachate
organic
microorganisms
decay
bacteria
sterilized
decomposition

NAME_____

MINI LANDFILL WORKSHEET
week 1

1. The items which decomposed the most are:

_____

_____

_____

_____

2. The following items decomposed a little:

_____

_____

_____

_____

3. These did not change at all:

_____

_____

_____

_____

4. Why do you think some items are decomposing more quickly than others?

_____

_____

_____

_____

NAME_____

MINI LANDFILL WORKSHEET
week 2

1. The items which decomposed the most are:

_____

_____

_____

_____

2. The following items decomposed a little:

_____

_____

_____

_____

3. These did not change at all:

_____

_____

_____

_____

4. What significant changes have you seen since last week?

_____

_____

_____

_____

NAME_____

MINI LANDFILL DISCUSSION QUESTIONS

1. Which items in the mini landfill decomposed the most?

_____

2. Were the decomposed items manmade or natural?

_____

3. Were the decomposed items biodegradable? How do you know?

_____

4. What characteristics are shared by the items which decomposed quickly?

_____

5. As you have discovered, some items did not decompose in your landfill. Do you think they will remain unchanged for a long time? If your answer is yes, can you tell why?

_____

6. In what other ways could we dispose of these items?

_____

7. Did mold form on your landfill? If yes, why did this occur?

_____

8. What do you think happens to waste left out in the desert?

_____

9. Suppose that your landfill was made with sterilized potting soil. Would waste have decomposed as quickly? Why?

_____

10. Did you notice any spaces around the waste items as you dug them up? What caused the space to form? If this happened in a real landfill, how could it affect the future use of the land after the landfill closed?

_____

TEACHER'S PAGE

MINI LANDFILL DISCUSSION QUESTIONS

1. Which items in the mini landfill decomposed the most?
   LIST WILL VARY

2. Were the decomposed items manmade or natural?
   NATURAL

3. Were the decomposed items biodegradable? How do you know?
   PROBABLY YES, RAPID DECOMPOSITION, PRESENCE OF MICROORGANISMS

4. What characteristics are shared by the items which decomposed quickly?
   ANSWERS WILL VARY THEY ARE NATURAL, ORGANIC ETC.

5. As you have discovered, some items did not decompose in your landfill. Do you think they will remain unchanged for a long time? If your answer is yes, can you tell why?
   YES, BECAUSE THEY ARE NOT BIODEGRADABLE, DECOMPOSITION WILL TAKE A VERY LONG TIME.

6. In what other ways could we dispose of these items?
   REUSE, RECYCLE

7. Did mold form on your landfill? If yes, why did this occur?
   IF YES, BECAUSE OF MOISTURE AND MICROORGANISMS

8. What do you think happens to waste left out in the desert?
   IT IS PRESERVED, WITHOUT MOISTURE THERE ARE NO MICROORGANISMS TO PRODUCE DECOMPOSITION

9. Suppose that your landfill was made with sterilized potting soil. Would waste have decomposed as quickly? Why?
   NO, STERILIZED SOIL CONTAINS NO MICROORGANISMS

10. Did you notice any spaces around the waste items as you dug them up? What caused the space to form? If this happened in a real landfill, how could it affect the future use of the land after the landfill closed?
    DECOMPOSITION IN PLACE, LAND COULD BE UNSTABLE, POTENTIAL FOR COLLAPSE

Lesson IV

EVEN TRASH NEEDS A BREATH OF FRESH AIR!

Science Activity

Students will compare the biological activity in three different waste disposal systems and be able to identify which conditions are conducive to decomposition.

MATERIALS NEEDED

Three wide-mouthed glass jars or beakers, soil, organic wastes, clear plastic wrap, elastic bands, worksheet to record daily observations

IMPLEMENTATION

Tell students that they are going to experiment with three types of waste disposal systems in order to compare how well they work in breaking down biodegradable materials.

Have students prepare the three systems according to the following directions. Encourage them to compare the differences and similarities in the breakdown which occurs.

To represent *open dumping* (aerobic conditions), layer two inches of rich soil in a glass jar. Place several pieces of garbage (orange peel, newspaper scraps, lettuce, egg shells, apple core etc.) on the surface. (NOTE: do not use meat and dairy products, for the sake of avoiding odors in the classroom.) Moisten the soil, cover with clear plastic wrap and seal with a rubber band. Add water as needed to keep the soil moist. Remove the cover every three days for a few minutes to allow air in. Record disintegration and mold formation daily.

To represent a *properly managed landfill* (partially aerobic conditions), set up a second beaker with two inches of soil. Insert several small samples of organic waste, placing them near the outer edge of the container for ease in observation. Cover with two more inches of soil and press down. Cover jar as in the experiment above. Moisten soil as needed. Record observations of decomposition and mold formation.

To demonstrate an *improperly managed landfill* (anaerobic conditions), half fill a third beaker with soil, add samples of organic waste, then add water to within two inches of the top. Stir vigorously, then cover tightly. Observe mixture daily, noting formation of odor and/or gases. (Methane, a product of anaerobic decomposition, will produce an occasional bubble through the water.) Compare the observations with those from the two previous methods.

Which was the most effective environment?

VOCABULARY

aerobic
anaerobic
biodegradable
decomposition

SOURCE

Teaching Resource Recovery in the Classroom

NAME_____

EVEN TRASH NEEDS A BREATH OF FRESH AIR!

Worksheet

DAY	Open Dump	Proper Landfill	Improper Landfill
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			

Lesson V

SOIL – DOES IT MAKE A DIFFERENCE?

Science Activity

Students will conduct experiments comparing the water-holding capacity of various soils, to determine the importance of soil studies prior to the siting of landfills.

MATERIALS NEEDED

Plastic containers (empty juice or milk jug), cups of pebbles, gravel, coarse sand, fine sand, topsoil, clay (any soil samples available), watch or clock with second hand, jars of water, bowls, measuring cup, student worksheets (one per pupil or group)

IMPLEMENTATION

To prepare containers, perforate the cap of each plastic jug and cut off the bottom end. Replace the cap, then fill the container about two-thirds full with one kind of soil. Repeat with as many types of soil as desired. In addition, prepare a separate container of soil in which you place several tablespoons of powdered paint into a well in the soil, and cover completely so that students will not know the paint is there.

You may wish to have the entire class conduct one experiment, or you may prefer to divide the class into small groups, allowing each to conduct the experiment and then compare results. Distribute worksheets to groups or individuals.

Select one of your soil containers. Pour in one pint of water, noting the time you begin to pour. Place a bowl underneath the container cap to catch the water. Record how much time passes before the water starts dripping into the bowl and the duration of the water dripping. Measure the amount of water that came through and compare with the amount with which you started.

Discuss: What happened to the remaining water? What conclusions can be drawn?

Repeat the experiment with each type of soil. When the experiment is performed with the soil containing the paint, your students will be surprised to see colored water. Discuss with students the fact that, like the paint, there are many hazardous wastes buried in the ground which are not detectable to the eye. Although the land beneath a landfill may "look" all right, continuous testing must be done to detect hazards before they leach into groundwater supplies.

Share the newspaper article with students as a factual illustration of the problem.

Discuss: What types of soil would students recommend be the base for landfills? Why?

Have students consider the following problem: there is a swamp about 15 miles from your town. The land cannot be used for farmland and no one builds homes in a swamp. Would this be a good location for a future Rhode Island landfill?

EXTENSION

Fill several large cans with soil, each with a different type, (gravel, sand, clay etc.). Press a sharpened 1/4" dowel (or pencil) into each can, to see how far it can be inserted. Compare and record results. Next, wet the soils and try again. Let the soils dry and record results a third time. Students can make comparisons among the soils and among the three tests, and make judgments on which types of soil were the most or least compact. Compare results with the above experiment.

VOCABULARY

groundwater
hazardous waste
leach
percolate
soil

SOURCES

Environmental Experiments from Edison
The Everyday Science Sourcebook

NAME_____

SOIL – DOES IT MAKE A DIFFERENCE?

SOIL TYPE	TIME ELAPSED BEFORE PERCOLATION BEGINS	TIME ELAPSED UNTIL PERCOLATION IS COMPLETED	AMOUNT OF WATER RELEASED FROM SOIL	CONCLUSIONS

EPA TESTING FINDS CONTAMINATED WATER IN 7 OF 31 HOMES NEAR CENTRAL LANDFILL

FURTHER TESTS ARE NEEDED TO PINPOINT SOURCE OF POLLUTION

by Bruce D. Butterfield
November 27, 1985

JOHNSTON – More than 20 percent of the private wells tested recently by the Federal Environmental Protection Agency in a limited sampling of wells near the Central Landfill have turned up contaminated.

However, an EPA official handling the tests says the results are preliminary and that it is too early to determine if the suspected contamination is coming from the landfill or other sources.

In all, the EPA tested 31 wells to the north and west of the state's huge landfill. Seven have been found to be contaminated with either heavy metals or chemicals at levels making them unsafe for drinking, according to EPA.

"We've notified those seven to advise them not to use the water for cooking or drinking," Kenneth E. Wenger, EPA site manager at the landfill, said. He said the remaining well owners are being advised this week of the test results.

The EPA finding is potentially significant because the wells tested were all upgrade of the landfill, meaning they are in the opposite direction of the ground-water flow.

Critics of the Central Landfill have long argued that ground water contamination may be occurring all around the site, not just downgrade toward Shun Pike and the Simmons Reservoir.

Wells in that direction were not tested by the EPA because several are known already to be contaminated, although it has not been proven that the landfill is the source.

This latest round of testing on the Bishop Hill side of the landfill was not scientifically random. Several of the wells tested had been checked before by private laboratories or the state, with mixed results.

The 31 wells tested were each examined for a wide range of chemicals, metals and other potential contaminants. The EPA undertook the testing last August after the state Solid Waste Management Corporation, which owns the landfill, rebuffed an EPA request that it test the wells.

Wenger said five of the bad wells were found to be contaminated by lead at levels well above those considered safe for drinking. He said the tests would have to be looked at further by the EPA, but he doubted the lead contamination came from the households' piping because of the high levels and because most samples were taken directly from the wells.

The sixth contaminated well contained two solvents, tetrachloroethylene and trichloroethylene. The seventh well was contaminated with sodium and nickel, with trace levels of benzene and tetrachloroethylene.

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Lesson VI

THE LARGEST LANDFILL

Reading Activity

Students will read background information about the Rhode Island Central Landfill and outline the material.

MATERIALS NEEDED

"Little Rhody and the Largest Landfill" (one per student), outline form (one per student) or paper for outlining, depending upon level.

IMPLEMENTATION

Display transparency detailing Rhode Island's landfill and discuss with students the path which trucks and waste follow as well as the volume of waste arriving at the landfill. A field trip to the Central Landfill (contact James Doorley, Landfill Manager, 942-1430) would graphically display Rhode Island's trash problem to students.

Distribute "Little Rhody and the Largest Landfill" to students. Have students read it independently, or as a class. Students who are skilled at outlining should be assigned the task of creating an outline to identify the important information found in the reading material. You may choose to offer the outline form to pupils, instructing them to locate the details relevant to each main topic and complete the form independently. At another level, you may offer the outline form as a guide and instruct students in the construction of an outline. Such students may label the sections by main topic, and search for the details within each section.

EXTENSION

124,000 people are employed annually in the U.S. just to get rid of our trash. Challenge your students to identify as many different jobs as they can which help to dispose of our trash in a landfill. Answers should include: garbage truck driver, bulldozer operator, topsoil digger, transfer station operator, scale operator, landfill manager and environmental scientists.

VOCABULARY

compactor	safeguards	quarry
municipal	monitor	purification
industrial	face	waste-to-energy plant
sewage	commercial	methane
sludge	topsoil	flyash

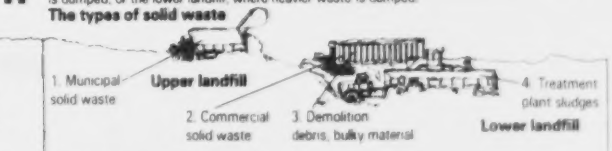
Rhode Island's landfill: Operating a growing concern

1. On the weigh in

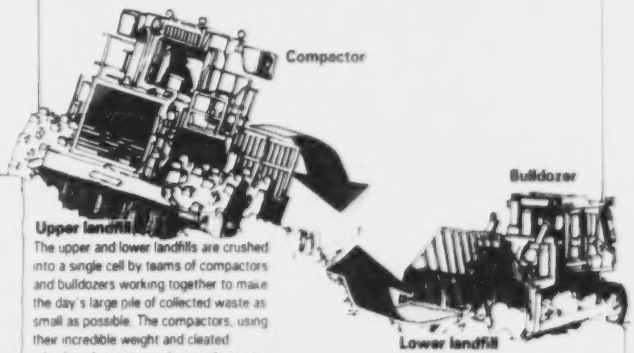
Between 400 and 500 trucks dump roughly 3,500 tons of solid waste a day at Central Landfill. Most of the activity is directed from the scale house, near the entrance of the landfill site. When a truck arrives, filled with waste, it's weighed and the driver is asked questions such as where the garbage is from and what type of waste it is.

2. Not all waste is equal

At the landfill, solid waste is divided into four basic groups to make the most of the limited space available. Depending on the type of waste a truck is carrying, the driver will be instructed to go to either the upper landfill, where lighter, more easily packed municipal waste is dumped, or the lower landfill, where heavier waste is dumped.



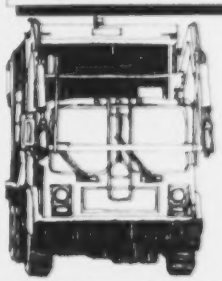
3. Using up as little space as possible



The upper and lower landfills are crushed into a single cell by teams of compactors and bulldozers working together to make the day's large pile of collected waste as small as possible. The compactors, using their incredible weight and cleated wheels, ride continuously over the upper landfill, packing it and crushing it down into the voids of the lower landfill. The lower landfill in turn is being pushed back up into the path of the compactors to be crushed again.

Landfill maintenance

As trucks come and go all day, the landfill takes a beating, particularly in wet weather, and needs constant upgrading. The waste becomes very soft, and makes travel difficult. So, roads of crushed stone and process gravel (excavated from the landfill site) are constructed. These roads change daily.



4. On the weigh out

After a truck's waste has been dumped, the truck reports back to the scale house to be weighed again before it leaves the landfill. The difference in the weight of the full truck and the empty truck, is what the driver, or his employer, will be charged for. (If the truck visits the landfill often, a record of the truck's empty weight is on record and this second scale house stop may be unnecessary.)

The landfill today

The Central Landfill is located in Johnston, and is owned by the Rhode Island Solid Waste Management Corporation. The landfill currently serves most of the municipal and commercial waste generators in the state, but the owners say it will have to be expanded to continue that service and to accommodate ash from three proposed incinerators that will turn waste into ash.

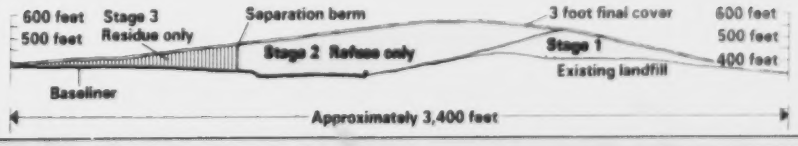
The landfill site has a licensed area of 154 acres, with waste existing now on 121 of them. At the current rate, the landfill's life has only another three years or so before the site will be filled. The changes being proposed to extend the life of the landfill consist of three phases, and the work will progress in three stages. Phase I encompasses the area of the existing landfill. Phases II and III will be located on the unused 33-acre portion.

The landfill tomorrow

Stage 1 of the project will complete the existing landfill. Stage 2 will be the filling of Phase II with the same type of refuse currently being used to fill Stage 1. Stage 3 will be the filling in of Phase III with ash, separated from Stage 2 by a wall-like separation berm. Under Phases II and III a liner will be used to prevent leaking.

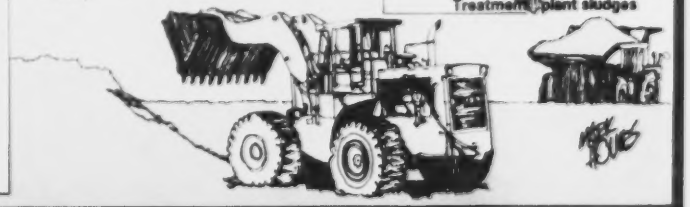
The owners of the landfill contend that these changes will extend the life of the landfill by about 20 years — a necessary change if the landfill is to remain the primary source for Rhode Island's solid waste disposal.

North



5. At the end of the day

At 4 p.m. work begins to seal the cell started earlier that day. This is done, in part, to contain odor. The cell's cover material, earth excavated from the landfill's site, must be at least six inches thick and cover all the waste collected that day.



SOURCES: *Rhode Island Solid Waste Management Corp.; Wehran Engineering; Goldberg-Zoino & Associates, Inc.*

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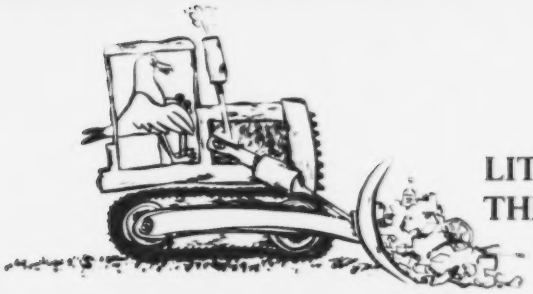
—Journal-Bulletin Graphic by MARK R. HOLMES



LITTLE RHODY AND THE LARGEST LANDFILL

The largest landfill in New England is the Central Landfill in Johnston, Rhode Island. It covers 604 acres in all. But only one-fourth of that space can be used to pile up the trash. Eighty percent of Rhode Island's waste comes to the Central Landfill. Three to four thousand tons of trash are brought here each day. Some is municipal waste and some is from industries. Building debris, non-hazardous liquid waste and sewage sludge are accepted. Each day enough trash comes in to fill a 200 by 200 foot space, 15 to 20 feet high. That's as big as 44 classrooms!

Every day more than 450 garbage trucks drive up to the landfill office to weigh in. After a truck's weight has been recorded, it continues up the dusty road to the active face of the landfill. There, each truck dumps its load of garbage. Out comes a jumble of garbage bags, tires, broken appliances, tree limbs and brush. While the garbage truck is driving back down the road, the bulldozer/ compactors go to work.

The landfill has seven compactors. A crew works to see that at least five of them are running each day. The machines have huge spiked wheels and rectangular rakes or blades. Each one costs $250,000 and they last only five years. Their drivers spend 10 hours each day moving up and down the mountain of trash. Their job is to compact the trash, making it as solid as possible.

The garbage truck returns to the office where it is weighed once more. The difference in weight equals the amount of trash deposited. A community pays for each ton of garbage dumped. This is the residential tipping fee. A higher fee is charged for commercial waste from businesses and construction sites.

In other corners of the landfill, rocks are broken up and topsoil excavated. The rocks are used to build the roads running through the site. Topsoil is needed constantly to cover the working face. In spite of the soil cover, on windy days trash litters the open spaces. Seagulls glide over the trucks or perch on the face awaiting their lunch. The smell of garbage is strong and sometimes nauseating. Workers say they get used to it.

There are safeguards practiced at the landfill. Eleven wells monitor groundwater. Four surface wells check runoff. Four times a year, tests are run to see which chemicals are leaching into the soil. At one time, hazardous waste was stored in part of the landfill. This area was closed and capped in 1982. Studies have been done on the flow of groundwater. Nearby homes must have their wells tested often.

The landfill site was first used as a quarry and a dump. It was run as a private landfill from 1955 until 1980. Then it was sold to the Solid Waste Management Corporation. The State of Rhode Island directs its operation. By law, the landfill must close when it reaches a height of 575 feet above sea level. At the end of 1985, the highest point was 450 feet tall. Experts think that the landfill will have to close in five years. If more towns use the Central Landfill, it will fill even sooner.

Landfills give something back to us: methane gas. First, bacteria help to break down the organic wastes. That yields a mixture of gases. Methane is one. It can be used, like natural gas, to make heat and electricity. A process to recover and use methane was developed. More than 25 methane gas recovery plants are now at work in the United States. Tests have been conducted at the Central Landfill to determine the size of our methane supply. The good news is that this gas can be sold to help pay for the high cost of running the landfill. The bad news is that methane pipes can't be placed in an active face of the landfill. When the landfill closes, a purification plant must be built. Then the methane can be put to use. The hope is that pipes from the Central Landfill could supply enough power for 300 Rhode Island homes.

When the landfill does close, several things could happen. Methane gas production could begin. Recreation areas such as parks or ski slopes could be built on the site. No new landfills are expected to be sited in Rhode Island. The land is too costly and no one wants a landfill in his or her neighborhood.

We have to reduce the amount of trash that each of us produces. Careful shopping and recycling should help. Building a resource recovery plant would lessen the amount of waste placed in the landfill. Rhode Island is the only New England state without a waste-to-energy plant. We must use every method we can to extend the life of *this* landfill as long as possible.

NAME_____

LITTLE RHODY AND THE LARGEST LANDFILL

Outline Form

I. Important Facts
   - A. Location
   - B. Size
   - C. Usage
   - D. Daily Traffic

II. Method of Operation
   - A. Trucks
   - B. Compactors

III. Machinery
   - A. Number
   - B. Description
   - C. Cost
   - D. Lifespan

IV. Remaining Landfill Usage
   - A. Topsoil Usage
   - B. Rock Usage

V. Safeguards
   - A. Surface Well Testing
   - B. Hazardous Wastes Precautions
   - C. Drinking Wells

VI. History/Future
   - A. First Uses
   - B. Private Landfill
   - C. Present Owner
   - D. Legal Limit
   - E. Present Elevation
   - F. Predictions
   - G. Future Plans

VII. Methane
   - A. How It's Made
   - B. Possible Use
   - C. Benefits
   - D. Drawbacks
   - E. Potential Yield from Central Landfill

VIII. Methods to Extend Life of Landfill
   - A.
   - B.
   - C.

Lesson VII

SO HOW MUCH IS THERE?

Math Activity

Students will read a table concerning figures on solid waste production and disposal sites and apply math skills (addition, subtraction, multiplication and division of whole numbers) to data on table.

MATERIALS NEEDED

"WORK IT OUT" (one per student), Table 1, overhead projector (or one copy of Table 1 per student)

IMPLEMENTATION

Distribute worksheet. Explain to students that municipal solid waste is the trash generated by private citizens. In most communities, tax money pays for collection and disposal, although some cities maintain private haulers for which each individual homeowner pays a fee. Since the Rhode Island Central Landfill is owned by the state, state tax money further subsidizes the cost of disposal of municipal solid waste. Commercial solid waste, on the other hand, is generated by business and industry. Its disposal cost is borne directly by the manufacturer.

Discuss the information presented on the table. Not every community uses the Central Landfill. Nine communities run their own landfills for the exclusive use of their citizens. Explain that Portsmouth, Newport, and Middletown did, at the time of these figures, transport their trash to a nearby Massachusetts landfill, to save transportation costs.

Review math procedures for word problems, identifying the process to be utilized in each problem if necessary. Students should work at their own pace, correcting completed work as a group discussion if you wish.

***BONUS** questions should be discussed, in order to ensure that the conclusions students are drawing about the solid waste problem are accurate.

VOCABULARY

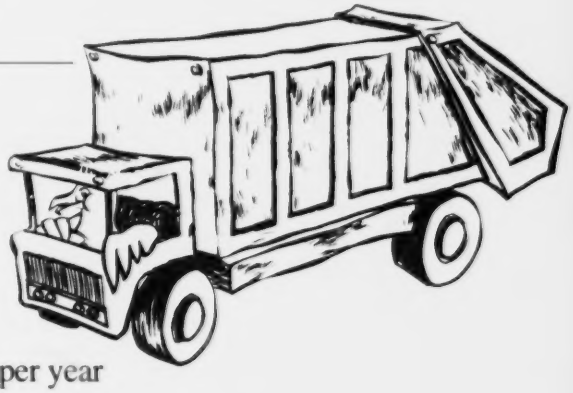
municipal solid waste (MSW)
commercial solid waste (CSW)
tipping fee
Environmental Protection Agency (EPA)

TABLE 1

COMMUNITY	MUNICIPAL SOLID WASTE RECEIVED AT CENTRAL LANDFILL	OTHER MUNICIPAL SOLID WASTE	COMMERCIAL SOLID WASTE RECEIVED AT CENTRAL LANDFILL	OTHER COMMERCIAL SOLID WASTE
BARRINGTON	8,100		1,800	
BRISTOL		9,000		4,320
BURRILLVILLE		5,000		1,400
CENTRAL FALLS	5,900		6,120	
CHARLESTOWN		2,000		810
COVENTRY	10,500		4,680	
CRANSTON	41,000		20,160	
CUMBERLAND	10,600		6,840	
EAST GREENWICH	5,900		4,320	
EAST PROVIDENCE	21,100		18,720	
EXETER	1,900		450	
FOSTER	1,700		270	
GLOCESTER	3,100		540	
HOPKINTON		3,000		720
JAMESTOWN	2,000		360	
JOHNSTON	10,400		7,200	
LINCOLN	7,300		8,640	
LITTLE COMPTON	1,800		450	
MIDDLETOWN		8,000		7,560
NARRAGANSETT	8,000		2,340	
NEWPORT		43,100		
NEW SHOREHAM		300		630
NORTH KINGSTOWN	10,400		11,160	
NORTH PROVIDENCE		13,000		7,920
NORTH SMITHFIELD	4,100		3,960	
PAWTUCKET	31,000		29,790	
PORTSMOUTH		6,000		5,400
PROVIDENCE	60,000		102,420	
RICHMOND		1,000		360
SCITUATE	3,400		900	
SMITHFIELD	8,100		5,760	
SOUTH KINGSTOWN	12,000		5,400	
TIVERTON		6,000		1,260
WARREN	5,400		4,320	
WARWICK	41,500		33,120	
WESTERLY		10,000		7,200
WEST GREENWICH	700		90	
WEST WARWICK	10,700		6,840	
WOONSOCKET	16,300		14,400	

SOURCE: RI Solid Waste Management Corporation, August, 1985.

NAME_____



WORK IT OUT!

Remember: MSW = municipal solid waste
CSW = commercial solid waste
The figures in Table 1 are in TONS per year
One ton = 2000 pounds

1. Middletown, Newport and Portsmouth trucked their waste to Massachusetts in 1985. How much MSW is that?

2. How much CSW do these three cities produce?

3. The other towns whose solid waste does not go to the Central Landfill have their own town landfills. How many town landfills are there?

4. Total the MSW for the towns in #3.

5. Total the MSW for Cranston, Warwick and Providence.

6. Find the difference between the totals in #4 and #5.

   ***BONUS:** Explain why three cities create more trash than nine.

7. What three cities have the most CSW sent to the Central Landfill?

   ***BONUS:** Explain why Providence has so much CSW.

8. What five cities have more CSW than MSW?

9. Find the city with the smallest amount of TOTAL solid waste. How many POUNDS per year does it create?

   ***BONUS:** Why is this town's amount of solid waste so small?

10. Find the difference between Woonsocket's MSW and Coventry's.

11. Find the difference between Foster's MSW and Barrington's.

    ***BONUS:** How do you think the population of a city and the solid waste it creates are connected?

12. In 1986, towns are charged $9 per ton to get rid of their MSW. How much does Cumberland have to pay?

13. How much does South Kingstown pay to dispose of its solid waste?

14. The "tipping fee" (charge per ton) for waste will rise each year at the Central Landfill. In 1990, the fee is expected to be $13 per ton. If Little Compton has the same amount of trash then as it does now, what will it cost the town to get rid of its solid waste?

    ***BONUS:** Would you predict that the amount of trash in Little Compton will change in the next five years? In what way, and how?

15. How much does your town pay now to get rid of its solid waste? (If your town does not use the Central Landfill, compute for Providence.)

16. If the Central Landfill closed now, trash would have to be trucked to Connecticut or Massachusetts landfills. Fees there are $90 per ton (as of December, 1986). How much would your town (or Providence) have to pay at $90 per ton?

    ***BONUS:** what can you do so that the Central Landfill won't fill up in the near future?

TEACHER'S PAGE

WORK IT OUT!

1. Middletown, Newport and Portsmouth trucked their waste to Massachusetts in 1985. How much MSW is that? 57,100 TONS

2. How much CSW do these three cities produce? 12,960 TONS

3. The other towns whose solid waste does not go to the Central Landfill have their own town landfills. How many town landfills are there? 9

4. Total the MSW for the towns in #3. 49,300 TONS

5. Total the MSW for Cranston, Warwick and Providence. 142,500 TONS PER YEAR

6. Find the difference between the totals in #4 and #5. 93,200 TONS

   ***BONUS:** Explain why three cities create more trash than nine. LARGER POPULATIONS

7. What three cities have the most CSW sent to the Central Landfill?
   CRANSTON, WARWICK, PROVIDENCE

   ***BONUS:** Explain why Providence has so much CSW.
   IT IS A HIGHLY INDUSTRIAL CITY.

8. What five cities have more CSW than MSW?
   CENTRAL FALLS, LINCOLN, PROVIDENCE, NORTH KINGSTOWN, NEW SHOREHAM

9. Find the city with the smallest amount of TOTAL solid waste. How many POUNDS per year does it create? WEST GREENWICH 1,580,000 POUNDS

   ***BONUS:** Why is this town's amount of solid waste so small?
   WEST GREENWICH HAS A SMALL POPULATION AND LITTLE INDUSTRY.

10. Find the difference between Woonsocket's MSW and Coventry's. 5800 TONS PER YEAR

11. Find the difference between Foster's MSW and Barrington's. 6400 TONS PER YEAR

    ***BONUS:** How do you think the population of a city and the solid waste it creates are connected?
    USUALLY, THE HIGHER THE POPULATION, THE GREATER THE AMOUNT OF SOLID WASTE GENERATED

12. In 1986, towns are charged $9 per ton to get rid of their MSW. How much does Cumberland have to pay? $95,400

13. How much does South Kingstown pay to dispose of its solid waste? $108,000

14. The "tipping fee" (charge per ton) for waste will rise each year at the Central Landfill. In 1990, the fee is expected to be $13 per ton. If Little Compton has the same amount of trash then as it does now, what will it cost the town to get rid of its solid waste? $23,400

    ***BONUS:** Would you predict that the amount of trash in Little Compton will change in the next five years? In what way, and how?
    IT WILL PROBABLY INCREASE, DUE TO A GROWING POPULATION AND INCREASED PACKAGING; ON THE OTHER HAND, IF CONSERVATION METHODS LIKE RECYCLING ARE PRACTICED, THE AMOUNT OF WASTE COULD BE REDUCED. REQUIRE STUDENTS TO JUSTIFY THEIR ANSWERS.

15. How much does your town have to pay now to get rid of its solid waste? (If your town does not use the Central Landfill, compute for Providence.)
    PROVIDENCE'S FEE AT $9 PER TON = $540,000

16. If the Central Landfill closed now, trash would have to be trucked to Connecticut or Massachusetts landfills. Fees there are $90 per ton (as of December 1986). How much would your town (or Providence) have to pay at $90 per ton?
    AT $90 PER TON, PROVIDENCE'S FEE WOULD BE $5,400,000

    ***BONUS:** what can you do so that the Central Landfill won't fill up in the near future?
    RECYCLE, REUSE, BUY ITEMS WITH LESS PACKAGING, COMPOST FOOD AND YARD WASTE, BE AN ENVIRONMENTALLY CONSCIOUS CONSUMER

Lesson VIII

A LANDFILL IN MY TOWN?

Reading and Map Activity

Students will become familiar with both past and present landfills in Rhode Island and locate them on a state map.

MATERIALS NEEDED

"R.I.'s Rubbish" (one per student), crayons or markers

BACKGROUND

Superfund was initially enacted in 1980 as the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) to provide funds to clean up the nation's worst hazardous waste sites. CERCLA provided $1.6 billion over a five year period and really only scratched the surface of the problem. Superfund Amendments and Reauthorization Act (SARA) was passed in October, 1986, and provides about $9 billion for another five years.

For a hazardous waste site, alias "toxic dump," to be eligible for Superfund money it must be on the National Priorities List (NPL). A site will make it onto the list if it scores high enough in the Hazard Ranking System, a point system which takes into account extent of contamination, public health threat and environmental impact.

The eight designated Superfund sites in Rhode Island are in differing stages of cleanup. Each site goes through the Superfund process which involves studying the site, deciding on a plan for cleaning up and/or immobilizing the contamination and implementing that plan. The Rhode Island Department of Environmental Management and the United States Environmental Protection Agency work jointly to supervise these projects.

IMPLEMENTATION

Distribute "Rhode Island's Rubbish". Discuss the map of Rhode Island. Help students to locate their own town.

Discuss the problems of illegal dumping. See the enclosed articles on "Big River Dump," "Rhode Island's Hazardous Waste Sites" and Lesson II for further information.

Have students follow directions and color in map.

EXTENSION

Discuss: Imagine the Central Landfill in Johnston closed. What effects does the map point out? (The great distance which trash would need to be hauled; the scarcity of available landfills in Rhode Island.)

Using the scale on the map, determine how far your trash must be hauled to reach the Landfill. If your town does not use the Central Landfill, either pick another town or discuss how much your town saves by hauling trash to a town landfill, if applicable. (Transportation costs in those cases are kept to a minimum.)

Contact the Director of Public Works in your community to determine if he/she has a person available to visit the class to describe the disposal system used in your town. See if you can determine the cost of your individual trash pickup.

VOCABULARY

groundwater
sediment
septage
solvents
Superfund

RHODE ISLAND'S RUBBISH

Most of our state's trash now goes to the Central Landfill. That was not always true. There are hundreds of old dumps or landfills in our state. Stricter laws forced many to close. They had been operating without many safeguards. Testing groundwater to protect our environment became the law.

In 1975, there were 44 landfills open for business in the state. Many of them became full and closed. More and more cities have to depend on the Central Landfill.

In the past, many landfills accepted hazardous wastes. As the laws became more restrictive, they closed. But the damage was done. Hazardous wastes were often dumped illegally. Sometimes wastes went to known landfill sites, sometimes they were just "thrown away" in remote wooded areas. As a result, Rhode Island now has eight sites on the EPA's Superfund list. The U.S. government provides money to clean up our worst hazardous waste sites. What is buried there is a severe threat to our health and environment.

Love Canal, in New York, is well known because toxic wastes were buried there. Many residents became ill. After careful study, the EPA found that Love Canal was a harmful place to live. The toxics buried in the ground were dangerous. Love Canal was closed and everyone moved away. No one will be able to live there again.

Superfund monies will be used to clean up the Rhode Island sites before they harm the people who live nearby. Drastic steps need to be taken to protect us.

COLOR THE MAP, FOLLOWING THE DIRECTIONS.

1. OPERATING LANDFILLS. All are run by the towns except Central, which is run by the state. Mark a green X in each town.

Central (Johnston)	Charlestown	Burrillville
North Providence	Bristol	Richmond
Westerly	Tiverton	Hopkinton
New Shoreham		

2. CLOSED LANDFILLS. These have closed since 1980. Many more are scattered throughout the state. Mark an orange X in each town.

Barrington	South Kingstown
North Smithfield	Exeter
Cranston	North Kingstown
Jamestown	Cumberland
Pawtucket	Glocester

3. KNOWN HAZARDOUS WASTE DUMPS. There are probably many more, not yet discovered. One source estimates that 2 million pounds of hazardous waste was being dumped here each month of 1977 alone! None of these wastes will disappear or degrade harmlessly. Each of these sites is on the Superfund List. Make a red X in each town.

Coventry – Piccillo's
Smithfield – Davis Liquid Waste
Johnston – Central Landfill
Cumberland – Peterson/Puritan
North Smithfield – Stamina Mills/Forestdale
Glocester/Smithfield Line – Davis Solid Waste
North Smithfield – Land and Resource Recovery
Burrillville – Western Sand and Gravel

4. Color the towns which use the CENTRAL LANDFILL blue.

Barrington	Central Falls	Coventry
Cranston	Cumberland	East Greenwich
East Providence	Exeter	Foster
Glocester	Jamestown	Johnston
Lincoln	Little Compton	Middletown
Narragansett	Newport	North Kingstown
North Smithfield	Pawtucket	Portsmouth
Providence	Scituate	Smithfield
South Kingstown	Warren	Warwick
West Greenwich	West Warwick	Woonsocket

5. Which town sends its waste to the Central Landfill from the farthest distance?

6. Where does your trash go?

7. What former waste facilities are located in your town?

8. Which hazardous waste site is closest to your home?

9. If we had another gasoline shortage, what problems does the map reveal?

RHODE ISLAND
Woonsocket
Burrillville
North Smithfield
Cumberland
Lincoln
Central Falls
Glocester
Smithfield
Pawtucket
North Providence
Scituate
Johnston
Providence
East Providence
Foster
Cranston
Barrington
Warren
Warwick
Coventry
West Warwick
Bristol
East Greenwich
West Greenwich
Portsmouth
Tiverton
Exeter
North Kingstown
Jamestown
Little Compton
Middletown
Hopkinton
Richmond
Newport
South Kingstown
Narragansett
Charlestown
Westerly
New Shoreham

RHODE ISLAND'S HAZARDOUS WASTE DUMP SITES

Prior to 1975, the state's solid waste regulations made no distinction between hazardous waste and solid waste. There is almost unanimous agreement among industry and government officials that prior to this date all sanitary landfills accepted what we now consider to be hazardous waste. In 1975, regulations were adopted requiring sanitary landfills to seek special permission to accept chemical waste. This permission was granted only to solid waste facilities which agreed to install monitoring wells and sample groundwater on a quarterly basis. Unfortunately, by that time, much damage was already done.

COVENTRY – Illegal chemical dumping at Warren V. Picillo's pig farm was discovered on September 30, 1977 when an explosion at the farm shook neighboring homes and belched up a thick cloud of black smoke. Investigation revealed that the farm had served as an illegal dumping ground. Up to 20,000 drums of chemicals (a 6000-cubic-yard pile of soil contaminated with cancer-causing phenols and PCBs) were buried there. The drums have since been removed to a secure hazardous waste landfill, but many problems remain. Pollution of groundwater and nearby surface water has occurred. Thousands of gallons of toxics were dumped straight into the ground from tank trucks. The result is Rhode Island's worst known hazardous waste site. Since the fire in 1977, state and federal agencies have spent about $6 million to remove the thousands of barrels of toxic chemicals. Nearby groundwater will need to be continuously monitored.

BURRILLVILLE – Western Sand and Gravel was once a quarry where, from 1975 to 1979, septage and liquid chemical wastes were dumped into unlined lagoons and pits. In 1978, the hazardous waste manifest system was implemented to protect us from chemical dumping. After studying the WS & G operation, DEM shut it down for violating hazardous waste laws. Twelve lagoons of industrial waste and septage were discovered. Sixty thousand gallons of liquids were pumped out, representing a tiny percentage of the wastes which had been dumped there and subsequently leached into the ground. Water filters were distributed to surrounding homes, and a public water line will be built in the future, as the groundwater beneath WS & G is unfit for consumption. The site will need to be permanently capped.

SMITHFIELD – The Davis Liquid Chemical Site was an open pit hazardous waste dump which operated in the mid-1970s until the courts ordered it closed in 1977. Evidence of pollution was brought to the court by concerned citizens working with the Conservation Law Foundation. An onsite fire revealed drums containing various chemicals and excavated pits filled with liquid chemical wastes such as chloroform, benzene and carbon tetrachloride. Water samples taken from nearby Latham Brook and surrounding areas revealed the presence of organic chemicals. More than 600 drums were removed under emergency EPA funding. Pollution of soil, groundwater, surface water and air has occurred here. Nearby homes must be supplied with bottled water and, eventually, a new water line will be run.

SMITHFIELD/GLOCESTER – From 1974 to 1982, William Davis operated the 58-acre GSR – Davis Landfill at the border of Smithfield and Glocester. Many problems have been encountered in installing and operating wells to monitor pollution. Such wells have revealed high levels of manmade organic contaminants including solvents, tetrachloride, toluene, benzene, heavy metals, mercury and lead. In addition, 11 acres of tires (estimated 30 million tires) present a tremendous fire risk.

JOHNSTON – Prior to state laws regulating hazardous wastes, such wastes were accepted at the Central Landfill which was owned at that time by the Silvestri family. When the Solid Waste Management Corporation took over the landfill operation, steps were taken to ensure that none of the hazardous wastes would contaminate the surrounding area. An impermeable membrane and several layers of fly ash were placed on top of the liquid disposal area to prevent rainwater from spreading the pollutants.

NORTH SMITHFIELD – Land and Resource Recovery was a private landfill which took in various municipal wastes as well as hazardous wastes. When laws became more stringent, L & RR was closed due to a ban on dumping hazardous wastes over underground water systems. Wells were installed to monitor the spread of contaminants in the groundwater. There was evidence that the contamination might be spreading toward the Slatersville Aquifer. A cap has since been put in place to prevent further contamination.

NORTH SMITHFIELD – The Stamina Mills Superfund site is located on the northern bank of the Branch River, just below Forestdale Pond. Some remains of the Stamina Mills textile weaving and finishing plant exist on the five acre site. In 1969, the mill began using trichloroethylene (TCE) in its process for cleaning newly woven fabric. The solvent was stored in an above-ground tank on site. Waste by-products from the cleaning process were deposited in an on site landfill. In the early 1970s, a TCE spill at the mill site contaminated the mill's well water. In 1977, a fire leveled the mill, the above-ground tank and the landfill. In 1979, the Rhode Island Department of Health discovered that the levels of TCE in some private wells around the site exceeded public health standards. The sampling also indicated the presence of tetrachloroethylene and 1,1,1 -trichloroethane. Several other investigations followed and in the spring of 1985, EPA and the State of Rhode Island closed the contaminated wells and installed a permanent water line from the North Smithfield public water system. Cleanup of the site has not yet begun.

CUMBERLAND – The Peterson-Puritan Superfund site is about two miles long and 2000 feet wide, running along both sides of the Blackstone River. The Blackstone River Valley Aquifer has supplied water to parts of both Lincoln and Cumberland. Routine water sampling in 1979 disclosed the presence of volatile organic contaminants. Peterson-Puritan Company, located in an industrial park northeast of these wells, was proven to be a major source of these chemicals. The company packages cleaning, polishing and sanitary preparations, perfumes, chemicals, toiletries and pesticides. A $750,000 settlement was given to the town of Lincoln to tie its public water supply into the Scituate Reservoir. Superfund monies will be needed to clean up the contaminated area.

SOURCE: Air and Hazardous Waste Division, DEM

WEST GREENWICH HOLDS ITS NOSE AS BIG RIVER DUMP MOUNTS

by Dave McCarthy
November 12, 1985

WEST GREENWICH – Police Chief Robert Andrews pulled his department's four-wheel-drive Bronco out of its parking spot at Town Hall for what should have been a pleasant ride in the country.

"Beautiful, isn't it?" Andrews said as he piloted the Bronco over Victory Highway toward what will be the Big River Reservoir – the $157 million project aimed at meeting Rhode Island's future water needs.

He spoke with an inflection that suggested the setting wasn't as beautiful as it seemed. As it turned out, he knew that the picturesque canopy – looking this day like a page out of Vermont Life – was a facade.

The chief's first stop on his drive was Division Road. He put the Bronco into four-wheel drive and left the facade behind by turning down one of the one-lane dirt trails that crisscross the reservoir land.

This trail was lined with rusted washing machines and stoves, empty beer bottles, old roofing and garbage. Deeper in the woods, behind the piles of junk and garbage, sat a burned-out Camaro.

Andrews bounced the Bronco down trail after trail. On each, there was more of the same. He was pointing out that West Greenwich, and a small portion of south-central Coventry, have an 8,600 acre dump on their hands – the land set aside for Big River.

"People just don't see it from the roads," Andrews said. "The junk is just everywhere, you know. They come in at night most of the time and shovel the stuff right off the back of pickup trucks. No one sees them."

Andrews used to try to prosecute those who dumped junk and garbage on the reservoir land. He would sift through the piles in search of something with a name and address.

"We'd get guys who would say they paid someone to take away their trash. Of course, they couldn't remember the guy's name. The judge would throw it out. He would say, 'Chief, you need more evidence. You had to see the guy in the area or something.' Other people we've caught said they thought it was a dump. They said, 'Hey, everybody dumps here.'"

He said the dumpers are always from out of town. As if to prove his point, he stopped at a freshly dumped pile of household trash. Letters in the trash all listed the address of a Coventry family.

The state bought the land and all the houses on it 20 years ago, but the dumping problem did not get acute until recently, Andrews said.

The state Water Resources Board, charged with overseeing the land, allowed the original homeowners to rent back their houses from the state. But as it prepares to build Big River – with the start of construction planned in two to three years – the board is not renewing as many leases as it once did. Once the state owned 200 homes, now it has 80.

William D. Falcone, of the Water Resources Board, said the removal of the junk and garbage will be included in a contract to demolish houses and cut down trees in the Big River zone.

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Lesson IX

LIFE AFTER LANDFILLS

Reading and Creative Thinking Activity

Students will apply their knowledge of solid waste problems to the determination of an appropriate use for a landfill site upon completion of the landfill operation.

MATERIALS NEEDED

"Life After Landfills" (one per student), "Central Landfills Map" (one per student), drawing materials

BACKGROUND

Virginia Beach, Virginia solved part of its trash problem in a novel way. A former dump was turned into a landfill/mountain. Named Mt. Trashmore, it was compacted and covered with 20 inches of topsoil when it reached a height of 80 feet. A 10,000 seat amphitheater, parking lots, roads and a soap box derby site were created. On the rare occasions when Virginia gets snow, people can actually ski down the slopes of Mt. Trashmore – a final resting place for 640,000 tons of trash! (NOTE: coincidentally, this is the amount of solid waste which Rhode Island disposes of each year!)

IMPLEMENTATION

Distribute worksheet and discuss. Share background information with students. You may wish to have the class discuss possibilities for the future of the landfill before students begin working independently, or you may choose to have students work individually from the start.

Upon completion, have the class evaluate and compare solutions. Discuss why some might be more practical than others or how some creative solutions might be just what the state needs!

EXTENSION

One student, or a group of students, could create their plan as a three-dimensional model. Displaying the 154-acre site of the actual landfill to scale (it will be a 300 foot mountain above remaining land) would bring this point home to your class!

VOCABULARY

compaction
leachate
methane

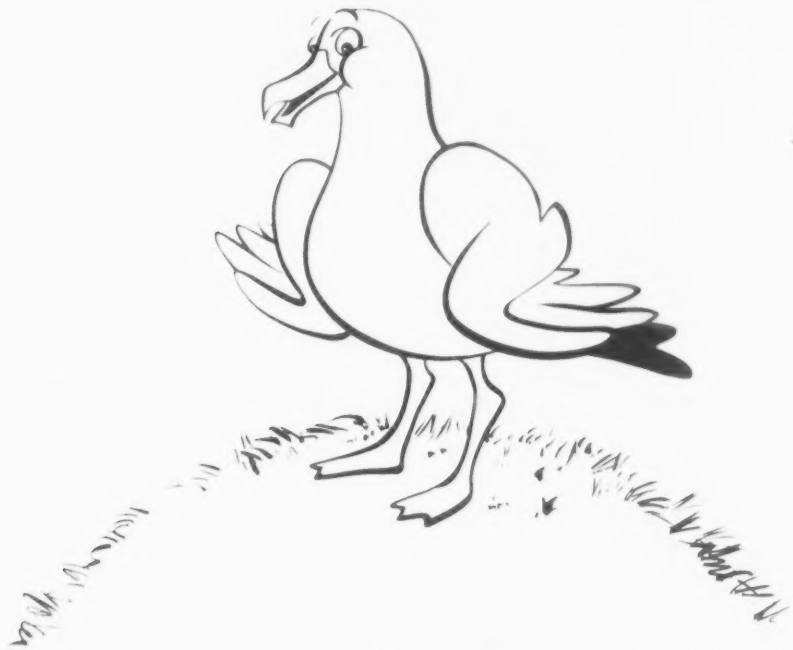
NAME_____

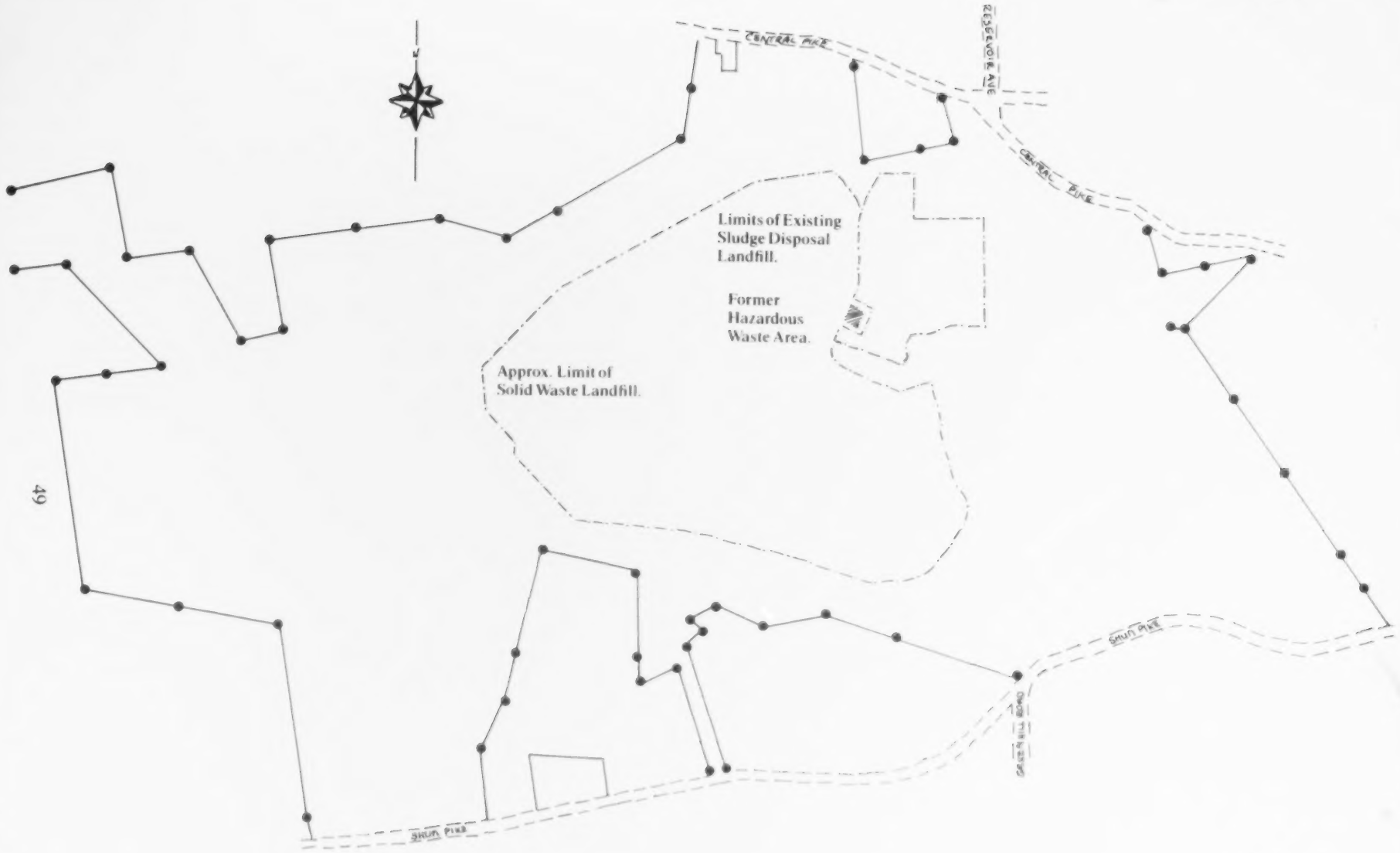
LIFE AFTER LANDFILLS

Once a landfill is filled to capacity, it doesn't disappear. A mountain, 200 to 300 feet tall, remains. At first, the trash sinks about 15 feet per year. Then, as the decay slows down, the rate of compaction lessens. At that point, the land can be used for something else. Parks, golf courses, ski slopes and baseball fields have all been built on closed landfills. Some homes have been constructed but this is not the safest use of the land. Further settling and methane production (even if it is untapped) can make building hazardous.

Study the diagram of Rhode Island's Central Landfill. It will probably be filled by 1990. Experts will need to spend a couple of years installing pipes for methane. They will also need to do some sealing off of leachate. That will assure no further pollution. Then what? We will have a 625-acre site, with a mountain in the middle. That's quite a large space. Roger Williams Park is just 450 acres!

USE YOUR IMAGINATION AND SOME GOOD SENSE. PLAN A SAFE, FUN-FILLED AFTERLIFE FOR THE LANDFILL.





175

CENTRAL LANDFILL MAP

176

NAME_____

LANDFILLS: UNIT EVALUATION

Match the definitions:

____	1.	SOLID WASTE	a) a machine that compresses solid waste, making it smaller
____	2.	SANITARY LANDFILL	b) the waste from a business
____	3.	HAZARDOUS WASTE	c) a gas with no smell or color which is produced by solid waste as it decomposes
____	4.	LEACH	d) trash and garbage
____	5.	METHANE	e) the amount charged for a truck, person or town to dispose of solid wastes at a landfill
____	6.	COMPACTOR	f) wastes which, due to their chemical makeup, can harm the environment
____	7.	TIPPING FEE	g) to leak
____	8.	MUNICIPAL SOLID WASTE	h) decayed organic waste which can be used for fertilizer
____	9.	COMMERCIAL SOLID WASTE	i) solid waste produced by homes
____	10.	COMPOST	j) a place where solid waste is disposed of by spreading it in thin layers and covering it with soil at the end of each day

Fold a piece of drawing paper into eight boxes. Arrange the following sentences in the correct order. Show what happens, over time, to a landfill. Illustrate each box.

- Machines are hard at work. They extract the rocks and topsoil that will be needed to cover the trash.
- Pipes are installed and methane gas is removed.
- Trees are cleared to make roads for garbage trucks.
- The landfill opens for business.
- Farmers grow crops in the fields.
- A park and ski slope are created.
- The mountain of trash grows as high as the allowed limit.
- Trucks bring in the trash, compactors daily pack it down, and soil covers it.

11. Give an example of something biodegradable.

12. Give an example of something which is not biodegradable.

13. How do resource recovery and recycling extend the life of a landfill?

14. Why does it cost money to have trash picked up by trash collectors?

15. Why is soil placed on top of trash at a landfill?

16. Why is testing done on groundwater at a sanitary landfill?

17. In the past 50 years, the amount of waste discarded per person in the U.S. has doubled. Can you explain why?

TEACHER'S PAGE

LANDFILLS: UNIT EVALUATION

Match the definitions:

1. d	6. a
2. j	7. e
3. f	8. i
4. g	9. b
5. c	10. h

Fold a piece of drawing paper into eight boxes. Arrange the following sentences in the correct order. Show what happens, over time, to a landfill. Illustrate each box.

3- Machines are hard at work. They extract the rocks and topsoil that will be needed to cover the trash.
7- Pipes are installed and methane gas is removed.
2- Trees are cleared to make roads for garbage trucks.
4- The landfill opens for business.
1- Farmers grow crops in the fields.
8- A park and ski slope are created.
6- The mountain of trash grows as high as the allowed limit.
5- Trucks bring in the trash, compactors daily pack it down and soil covers it.

11. Give an example of something biodegradable.

12. Give an example of something which is not biodegradable.

13. How do resource recovery and recycling extend the life of a landfill? BY REDUCING THE AMOUNT OF TRASH NEEDING TO BE BURIED

14. Why does it cost money to have trash picked up by trash collectors? TO PAY SALARIES OF ALL THE WORKERS AND TO COVER THE COSTS OF ENVIRONMENTAL SAFEGUARDS

15. Why is soil placed on top of trash at a landfill? IN ORDER TO SPEED DECAY AND REDUCE ODORS

16. Why is testing done on groundwater at a sanitary landfill? IN ORDER TO DETERMINE WHAT POLLUTANTS MIGHT BE LEACHING INTO GROUNDWATER SUPPLIES.

17. In the past 50 years, the amount of waste discarded per person in the U.S. has doubled. Can you explain why? THE AMERICAN LIFESTYLE, WITH FAR MORE PACKAGING, DISPOSABLE ITEMS, AND THINGS INTENDED FOR JUST ONE USE.

LANDFILLS

VOCABULARY

aerobic–able to live and grow with free oxygen

anaerobic–able to live and grow without oxygen

bacteria–single-celled living organisms that can cause disease; they also can break down solid waste

biodegradable–able to be broken down by microorganisms; includes most organic waste (food and paper)

commercial solid waste (CSW)–the waste from a business

compactor–a machine that compresses solid waste, making it smaller

compost–decayed organic waste which changes into humus (rich soil); can be used for fertilizer

consumers–people who buy goods and services

contaminants–things that pollute (make unpure or unusable)

decay–aerobic breakdown, chiefly by bacteria

decompose–to break down, change form

dispose–to get rid of, throw away

dump–open disposal sites (now against the law)

EPA (Environmental Protection Agency)–the federal office responsible for making sure that waste disposal does not harm our environment

fly ash–small bits of ash and soot which are made when coal, oil or wastes are burned

garbage–wastes (like food) that are likely to decompose

groundwater–water in the earth that supplies wells and springs

hazardous wastes–wastes which, due to their chemical makeup, can harm the environment

incineration–the process of burning to ashes; this process can reduce the volume of waste to be landfilled by about 90%

industrial–having to do with a business or industry

inorganic–things not made from plants, animals or from carbon compounds (glass and metals)

landfill–a place where solid waste is disposed of by spreading it in thin layers and covering it with soil

leach–to leak

leachate–liquid which drains out of landfills; it contains decomposed waste, bacteria and other contaminants

methane–a highly explosive gas with no smell or color which is produced by solid waste as it decomposes

microorganisms– microscopic living things involved in the composting of wastes and in sewage treatment processes

monitor–to check on regularly to be sure that there are no problems

municipal solid waste (MSW)-solid waste produced by homes

obsolete–no longer in style or use

organic–made from living organisms

pollution–the contamination of soil, water, or the air by the discharge of waste, gases, or chemicals

purification–to make something clean, or pure

quarry–a place where large amounts of stone are dug up and removed

recycling–using something more than one time

refuse–another name for trash

resource recovery–a process where energy is produced by burning solid waste; see incineration

runoff–rain or melted snow which flows over the land

safeguards–things which are done to protect

sanitary landfill–see landfill

sediment–the matter which settles to the bottom of a liquid

septage–the muddy or slushy substance pumped out of a septic tank; it must be processed at a sewage treatment plant

sewage-liquid or solid waste which is carried off by sewers and purified in a sewage treatment plant

sludge–the muddy sediment left after sewage has been processed; it must be landfilled

soil–the upper layer of earth which may be dug; dirt

sterilized–cleaned so that there are no contaminants

solid waste–trash and garbage

solvents–liquid substances that can dissolve other substances

Superfund–the money which the U.S. government has put aside to clean up hazardous waste sites

tipping fee–the amount charged for a truck, person or town to dispose of solid wastes at a landfill

topsoil–the top layer of soil containing valuable nutrients

transfer station–a place where solid waste is loaded into large trucks or railroad cars to go to landfills for disposal

trash–material to be thrown away; solid waste

waste-to-energy plant–see resource recovery

LANDFILLS

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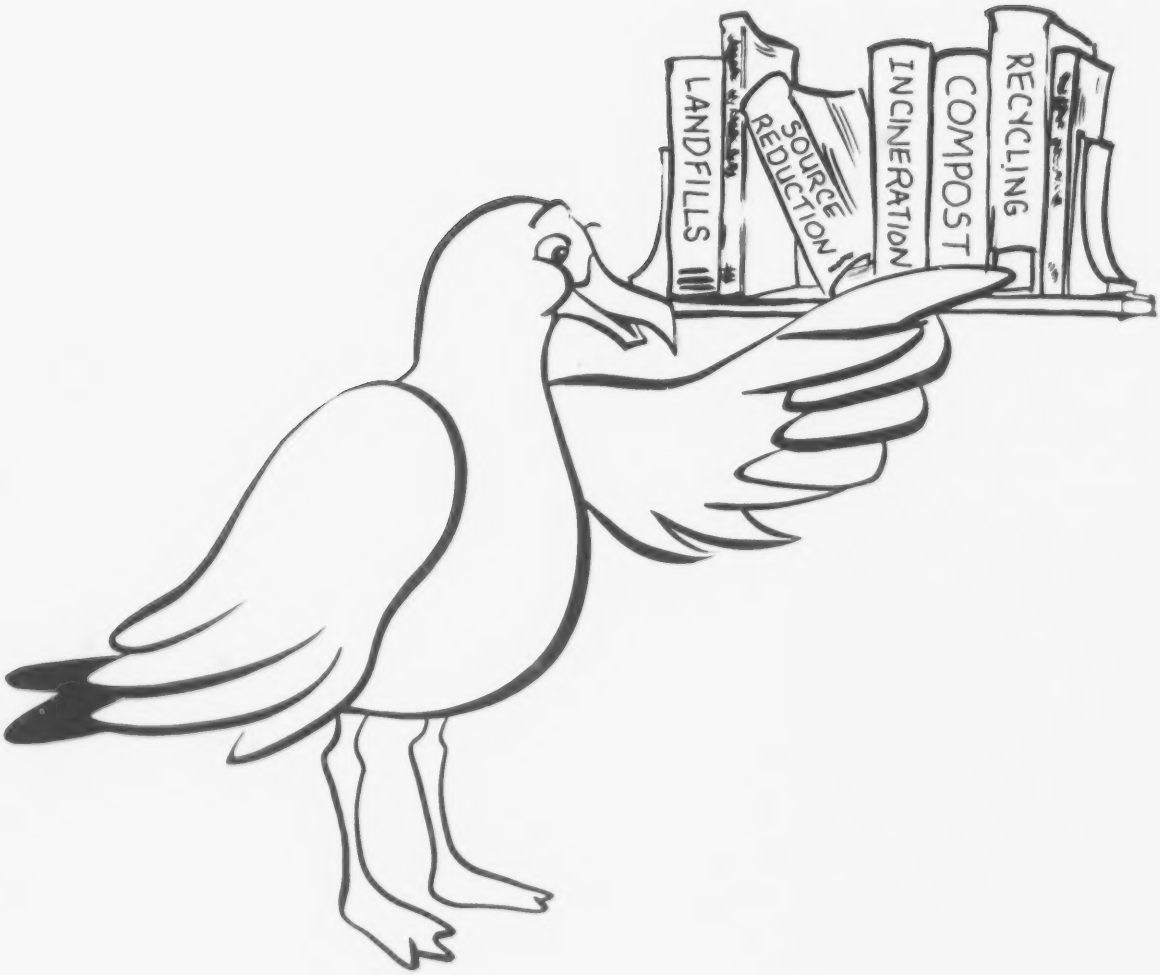
OSCAR'S OPTIONS
UNIT V
RECYCLING



RECYCLING

OBJECTIVES

1. Students will be introduced to the concept of cycles and observe four of nature's cycles.
2. Students will become aware of the variety of materials which can be recycled.
3. Students will create recycled paper and be able to explain the process of papermaking.
4. Students will read about the process of glassmaking and be able to explain the steps involved.
5. Students will be able to explain to their peers the benefits of recycling aluminum cans.
6. Students will recognize that the variety of plastic materials in use presents a major obstacle to recycling.
7. Students will create bar graphs to compare different beverage containers and determine which are the most ecologically sound.
8. Students will serve as educators by devising a method to share the information they have learned about recycling with families and neighbors.

RECYCLING

ACTIVITIES

I.	Cycle,Recycle	Introduction
II.	Around and Around	Math and Problem Solving
III.	Papermakingpapermaking papermaking	Science Activity
IV.	Waiter, There's Sand in My Glass!	Reading and Creative Thinking
V.	Once is Not Enough	Art and Reading
VI.	Ninety-Two Pounds of Trouble	Reading and Critical Thinking
VII.	The Choice is Clear!	Math
VIII.	Pass It On!	Evaluation

RECYCLING

TEACHER INFORMATION

These lessons were written with Grades 4 – 8 in mind. All student materials are written at a 6th grade reading level. The lessons in this unit are arranged sequentially, but individual lessons may be taught or deleted as best suits you and your class.

POSSIBLE IMPLEMENTATION OF RECYCLING UNIT

Monday	I. Introduction	20 min.
Tuesday	II. Math	30 min.
	Follow-up Activity (Homework)	15 min.
Wednesday	III. Science	60 min.
Thursday	IV. Reading and Creative Thinking	30 min.
Friday	V. Art and Reading	60 min.
Monday	VI. Reading and Creative Thinking	30 min.
Tuesday	VII. Math	45 min.

Lesson 1

CYCLE, RECYCLE

Introduction

Students will be introduced to the concept of cycles and observe four of nature's cycles.

MATERIALS NEEDED

"Cycle, Recycle" worksheet (one per student)

IMPLEMENTATION

Explain to students that a cycle is a series of events which reoccur regularly, usually leading back to the starting point. Plant and animal life depend on nature's continuous cycles.

Distribute worksheets to students, discuss the various cycles and instruct students to illustrate the steps involved in each cycle.

Explain that people can imitate nature by giving new life to materials that do not break down in the waste stream. Several products regularly found in solid waste from school and home can be recycled. That means they can be broken down, reprocessed and returned to active use rather than being discarded to take up space in the landfill or to contribute to our ever-present litter problems. Recycling benefits all of us by reducing the amount of solid waste, conserving energy, creating jobs and preserving our resources. Throughout this unit, students will become familiar with the materials which can easily be recycled and the methods by which they are reprocessed.

VOCABULARY

nutrients
decay
photosynthesis
evaporate
cycle
sediment
erode
minerals

NAME_____

CYCLE, RECYCLE

Illustrate each cycle.

NUTRIENT CYCLE

All living things need food, or nutrients, to grow. Plants take up nutrients from soil to make sugar. Animals then eat the plants. They return nutrients to the soil through body wastes. When plants and animals die and decay, nutrients are returned to the soil.

OXYGEN CYCLE

Plants give off oxygen as a waste product of photosynthesis. Animals take in oxygen as they breathe. They exhale carbon dioxide (CO_2). Plants use the carbon dioxide for photosynthesis.

WATER CYCLE

The sun evaporates water from rivers, oceans and lakes. Water vapor forms clouds when it cools. Clouds release water as rain. Water soaks into the ground for plants and animals to use. Water not used runs back into the lakes and oceans.

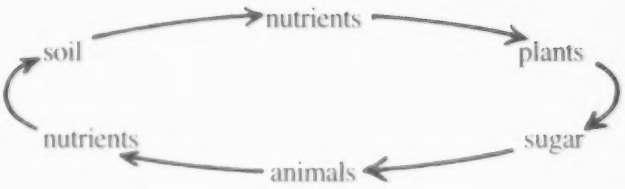
Teacher's Page

CYCLE, RECYCLE

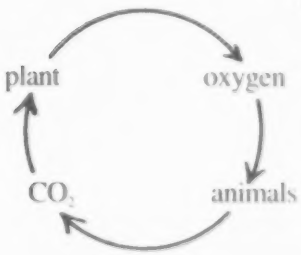
Illustrate each cycle.

NUTRIENT CYCLE

All living things need food, or nutrients, to grow. Plants take up nutrients from soil to make sugar. Animals then eat the plants. They return nutrients to the soil through body wastes. When plants and animals die and decay, nutrients are returned to the soil.



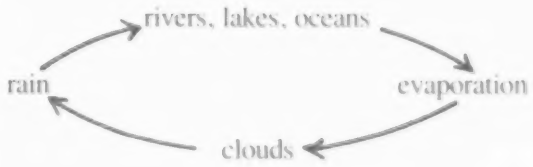
OXYGEN CYCLE



Plants give off oxygen as a waste product of photosynthesis. Animals take in oxygen as they breathe. They exhale carbon dioxide. Plants use the carbon dioxide for photosynthesis.

WATER CYCLE

The sun evaporates water from oceans and lakes. Water vapor forms clouds when it cools. Clouds release water as rain. Water soaks into the ground for plants and animals to use. Water not used runs back into the lakes and oceans.



Lesson II

AROUND AND AROUND

Math

Students will become aware of the variety of materials which can be recycled.

MATERIALS NEEDED

"An American Trash Can" and "Coded Recyclables," one each per student

BACKGROUND INFORMATION

The difference between the recycling effort in the 1970s and that of the 1980s is the underlying philosophy. In the 1970s, emphasis was on ecological benefits; the 1980s stresses the economic need for resource recovery. Very simply, municipal recycling programs reduce the number of tons of refuse that must be processed and/or landfilled. The extent to which recycled tonnage is removed from the waste stream:

a) reduces disposal costs on an absolute basis (ton for ton) by avoiding resource recovery and landfill operations.
b) it provides for an additional source of revenue from recycling income.
c) it saves fuel costs that are associated with a higher BTU requirement for glass and metals in mass-burn operations.
d) it reduces the amount of residue from rear-end resource recovery operations where metals and glass constitute the largest percentage of resource recovery residue.
e) it saves capital costs to the extent to which size of resource recovery plants are reduced in proportion to number of recycling tons removed from total waste stream.

BIOCYCLE, September, 1985

Prior to 1986, there were at least 50 recycling centers and businesses open in Rhode Island, about 20 of which paid cash for recyclables. Nine communities had local, voluntary programs and the R.I. Central Landfill was accepting recyclables (glass, aluminum, and newspaper) as well. The incentive for this effort, in spite of fluctuating markets, had been the tremendous savings of energy and natural resources, as well as the reuse of costly materials (rather than consigning them forever to take up valuable landfill space). Certainly the recognized shortage of landfill space is what prompted Rhode Island to develop a statewide mandatory recycling program in 1986. Of the 500,000 tons of residential waste transported to landfills by Rhode Island residents, it is estimated that 236,000 tons (47%) is composed of recyclable materials. At 1986 market values, our recyclable paper, glass and metal are worth approximately $5,000,000.

Recycling begins with source separation. As each Rhode Island community comes under the jurisdiction of SO849-subB (see general introduction), the habit of separating recyclables from trash must be developed. Recyclables are collected by regular trash pickup (where available) and transported to the Materials Recovery Facility (MRF). They are then further sorted into glass (by color), aluminum, other metals, paper, plastic etc. Each will be sent on to a manufacturer who reprocesses the material.

No tipping fee is paid by the community for disposal of recyclable waste. Removal of these materials from the waste stream not only increases the life of the landfill, but also increases the effectiveness of any resource recovery system.

IMPLEMENTATION

Tell students that on an annual basis, Americans discard 65 billion cans, 26 billion bottles and jars, 30 million tons of paper, 200 million tires and 4 million tons of plastic. Explain that much of this material could be recycled, saving both landfill space and valuable natural materials.

Distribute "An American Trash Can" to students and give them a few minutes to think about the viability of recycling each material. Present the following information and allow students to shade in each area representing recyclable materials as you discuss them.

PAPER – 30% of our general trash, about 40% of household trash. Each American uses about 580 pounds of paper per year. In 1980, we recovered 27% of our used paper. On the blackboard, list the paper materials which are often thrown away (newspaper, magazines, school work, letters, packaging etc.).

GLASS – 10% of our trash. Of 26 billion bottles and jars produced in 1981, only 1 in 15 was crushed and melted down to make new jars and bottles. List glass items that are commonly thrown away (food jars, bottles from toiletries and cleaners, beverages etc.).

METAL – 10% of our trash. There is now a 50-50 chance, on buying a soft drink in an aluminum can, that the can was made from other cans. The time between a can leaving the factory and returning to the melting furnace for reprocessing may be only 90 days. In 1981, Americans used 56 pounds of aluminum per person. List the various forms of metal which we discard (cans, metal bottle caps, old household appliances etc.).

FOOD WASTES – up to 15% of our trash. The world's largest composting facility, the Netherlands' VAM, produces about 125,000 tons of compost made from discarded food wastes each year. The compost is sold for farm and garden uses. List food items thrown away.

PLASTIC – 6%. Each different container type is made of a different plastic composition. Some types can be recycled. List plastic items and containers thrown out (shampoo, laundry detergent, dish soap containers, milk bottles, soda bottles, plastic wrap, trash bags, etc.).

YARD WASTES – 16%. Yard wastes could be placed in a compost pile, where they would naturally decompose. List yard wastes that now make their way to the landfill. (hedge clippings, wood ash, weeds, leaves etc.).

OTHER – 13%. A wide category which might include: rubber, clothing etc. While this is the only category which should remain unshaded on the students' graphs, there are some materials which fall in this category which could, in fact, be recycled (motor oil, tires, cars and car parts, asphalt etc.).

Discuss with students the impact that recycling could have on the vast amounts of trash we create. Although realistically perhaps only some of the materials within each category could be recycled easily, the overall volume of trash would certainly be diminished. Rhode Island's mandatory recycling bill requires that 15% of a town's waste stream be diverted for recycling. Tell students that throughout this unit they will learn exactly how these items can be recycled and reused.

FOLLOWUP

Distribute "Coded Recyclables". Urge students to apply deductive reasoning to the problem. Ask them to think about the items which they know can be recycled and to identify any words on the worksheet which fall into such a pattern. Hint: #3 and #5 are both two-word items. Elicit from students ideas about which things they can think of which might fall into such a pattern. If needed, supply them with one or two answers and have them apply the code to the other items.

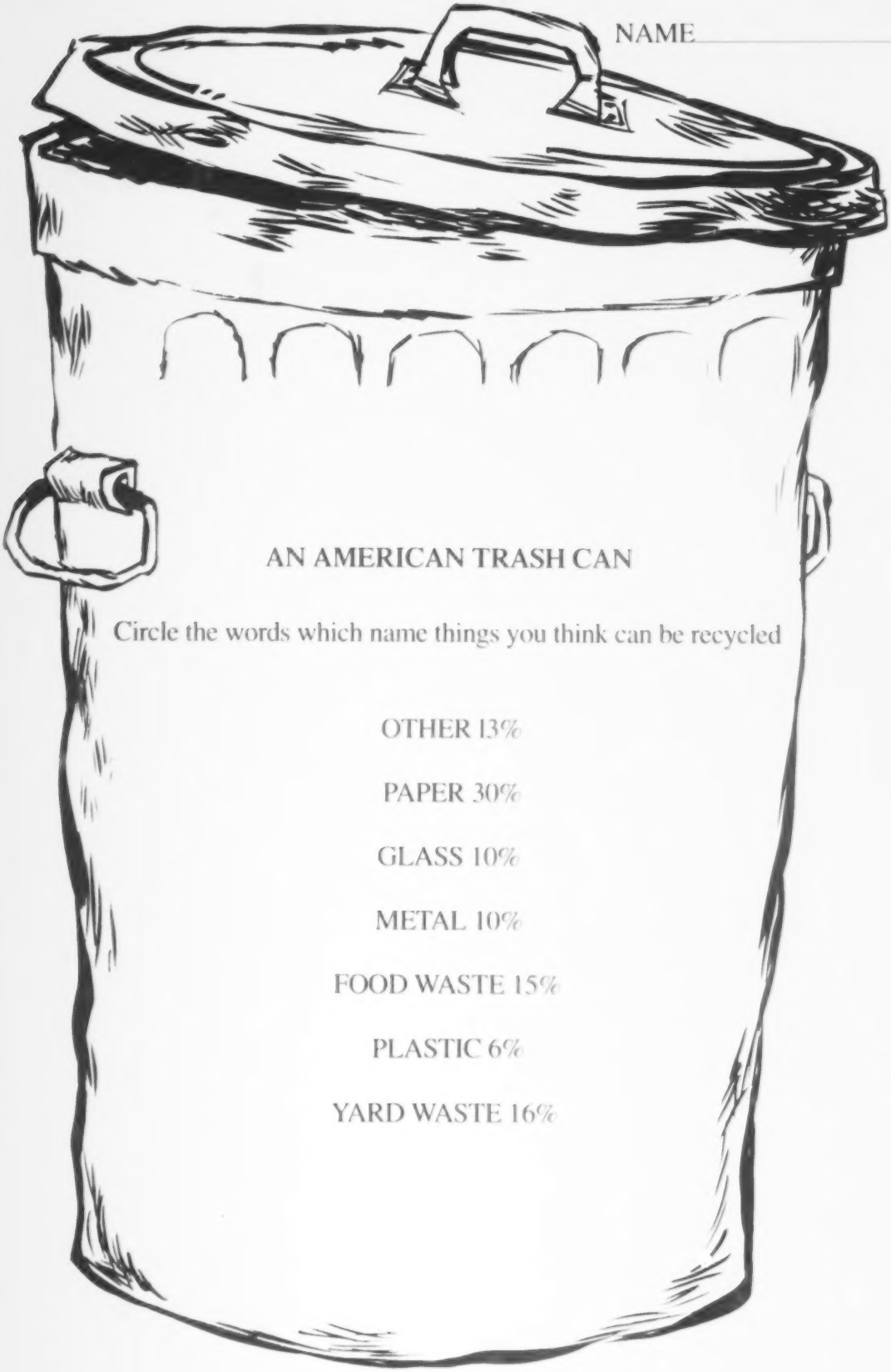
EXTENSION

"Recycling – A Lesson from Nature" is a short (five minute) film produced by Alcoa Aluminum to introduce aluminum can recycling. The film assumes that the viewer already understands natural soil and water cycles and the concepts of renewable and non-renewable resources. The film follows the aluminum cans through the recycling process from the individual collector to the recycling center and from there to the processor. The benefits of aluminum recycling to the community are listed, accompanied by supporting statistics. See also the brochure "It's Nature's Way" from Alcoa.

VOCABULARY:

MRF
tipping fee
recyclables

NAME _____



AN AMERICAN TRASH CAN

Circle the words which name things you think can be recycled

OTHER 13%

PAPER 30%

GLASS 10%

METAL 10%

FOOD WASTE 15%

PLASTIC 6%

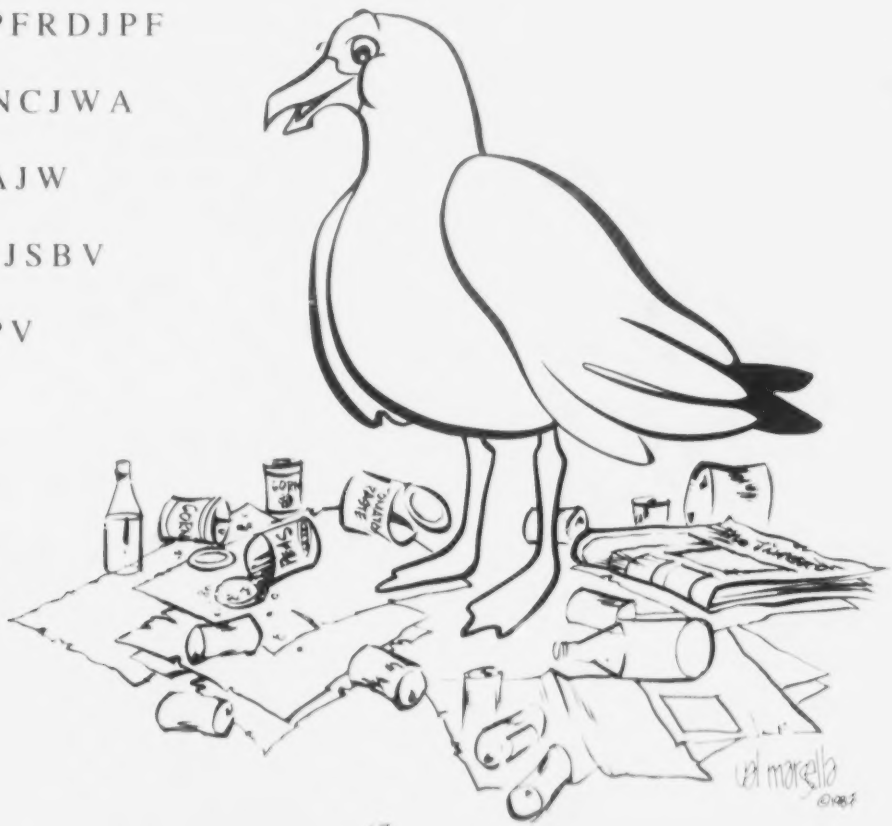
YARD WASTE 16%

NAME_____

CODED RECYCLABLES

All of these things can be recycled. They are in code, which means that one letter stands for another. Can you solve the code?

1. ZBEVNJNBP
2. OWJVV
3. IDADP DTW
4. ATPBV
5. JWYITZYI LJZV
6. LJPFRDJPF
7. JVNCJWA
8. IBAJW
9. WBJSBV
10. LJPV



Teacher's Page

CODED RECYCLABLES

All of these things can be recycled. They are in code, which means that one letter stands for another.

1. Z B E V N J N B P
   N E W S P A P E R

2. O W J V V
   G L A S S

3. I D A D P D T W
   M O T O R O I L

4. A T P B V
   T I R E S

5. J W Y I T Z Y I L J Z V
   A L U M I N U M C A N S

6. L J P F R D J P F
   C A R D B O A R D

7. J V N C J W A
   A S P H A L T

8. I B A J W
   M E T A L

9. W B J S B V
   L E A V E S

10. L J P V
    C A R S

Lesson III

PAPERMAKINGPAPERMAKINGPAPER

Science Activity

Students will create recycled paper and be able to explain the process of papermaking.

MATERIALS NEEDED

lots of newspapers, a variety of other paper goods, pieces of screen (old window screen), rolling pins, plastic sheeting (or an old shower curtain), blender, containers for water, large dishpans, several sponges

BACKGROUND

Between 1978 and 1980, Americans used 580 pounds of paper per person per year. Only about 27% of it was recycled. Recycling is important because it saves natural resources, reduces pollution and requires smaller amounts of energy. The manufacture of recycled paper requires 61% less water and produces 70% fewer pollutants than the manufacture of paper from virgin fibers. A 60% to 70% energy savings is also realized.

To produce one ton of paper packaging requires:

- 3,688 pounds of wood
- 216 pounds of lime
- 360 pounds of salt cake
- 76 pounds of soda ash
- 24,000 gallons of water
- 28 million BTUs of energy

Pollutants include:

- 84 pounds of air pollutants
- 36 pounds of water pollutants
- 176 pounds of solid wastes

IMPLEMENTATION

Begin activity by having students save various types of paper over the course of several days. Request that they bring in old newspapers for the project.

Share the following facts with your students:

- Paper constitutes at least 50% of the nation's municipal waste by volume.
- In an average high school, 85% of the wastes generated are either paper or paper products.
- The publication of the Sunday *New York Times* consumes 10,000 trees.
- Recycling a stack of newspapers three feet tall saves one tree.
- Recycling one ton of newspapers saves about 17 trees.
- Recycling one ton of newspapers conserves two to three cubic yards of landfill space.

Inquire about any paper recycling projects with which your students may have been involved. Some communities have separated newspapers for years. Some homeowners routinely save newspaper for other uses. Many civic groups have been involved in "paper drives" to raise money.

Explain to students that, as more communities become active in Rhode Island's recycling program, more trees will be saved and landfill space will not be unnecessarily filled with this easily recycled commodity.

Tell students that recycled paper often becomes new paper and paperboard products, insulation, packing and cushioning materials and building products. Cereal boxes, paper toweling, toilet paper, cake mix boxes, shoe boxes, candy boxes and many of the other paper goods we use daily all contain recycled fibers. Assist children in following the steps to create their own recycled paper. Depending upon the availability of materials, this could be performed as a whole class or a small group activity.

Have students begin by tearing the used paper into tiny pieces. You may wish to have one group use only newspaper, one group mixed papers and another group only ditto paper for comparative purposes.

Place a handful of paper shreds and 2 cups of hot water into the blender. Mix until it has a watery-creamy consistency, which means the paper fibers have broken down. Repeat with successive batches being careful not to overload the blender.

Fill a dishpan with 4-6 inches of water and pour the paper "slurry" into the pan. Mix by hand. Dip the piece of screen (6 x 9 inches is a good, workable size - tape the edges to avoid small cuts from the wire) into the dishpan with one motion, then bring it up horizontally, lifting pulp up on the screen. Let water drip for a few seconds, tilt to drain, then turn (pulp side down) onto spread newspapers (plastic sheeting underneath will further protect your work surface). Place sponge against screen to soak up excess water. Squeeze water into slurry bucket and repeat until you've soaked up as much water as possible. Slowly remove screen. Flip recycled paper and newspaper onto more newspapers and pat dry or use rolling pin. SLOWLY AND CAREFULLY peel paper up and set in a warm place to dry (1-2 hours).

Options: add food coloring or bits of grass, leaves, dried flowers or other natural materials either directly to blender or into slurry. Also, pieces of colored construction paper will add visual interest to your finished paper.

If, at any step, the paper is unsatisfactory, just crumble it back into the dishpan of slurry and try again. Experiment with different colors and thicknesses. The younger your students, the thicker your slurry and paper should be, to allow for greater success. When the slurry is not producing thick enough paper, add more blended pulp.

Explain to students that in the usual manufacturing process of recycling paper, machines perform all of the tasks the students did. Used paper is deposited in a pulper (a giant mixer continually filled with water, with a rotor in the middle and a sieve at the bottom). The rotor forces the water and paper to mix, breaking the paper into wood fibers. The fibers then go through a sieve and paper fibers are picked up from the water by heated cylinders which turn in a trough filled with paper stock. The cylinders deposit fibers onto a belt, matting them together until the desired thickness of paper is obtained. The wet sheets of paper pass over drying cylinders. The new paper will be off-white or have tiny colored fiber flakes. Virgin wood fibers can be combined with recycled paper fibers to make a higher quality paper.

Compare the students' recycled paper with other available papers in the classroom. Display pages of OSCAR's Options (printed from 100% recycled paper) for students to observe.

FOLLOW UP

"How Paper Is Recycled" can be completed as a homework assignment.

EXTENSION

Encourage students to recycle (save for collection) or reuse (both sides and scraps for art projects) all paper in the classroom.

Purchase 12 x 12 inch pieces of particle board, one per student. Paint one side with slate colored paint and supply students with chalk. Encourage them to use their slates, instead of paper, whenever practical.

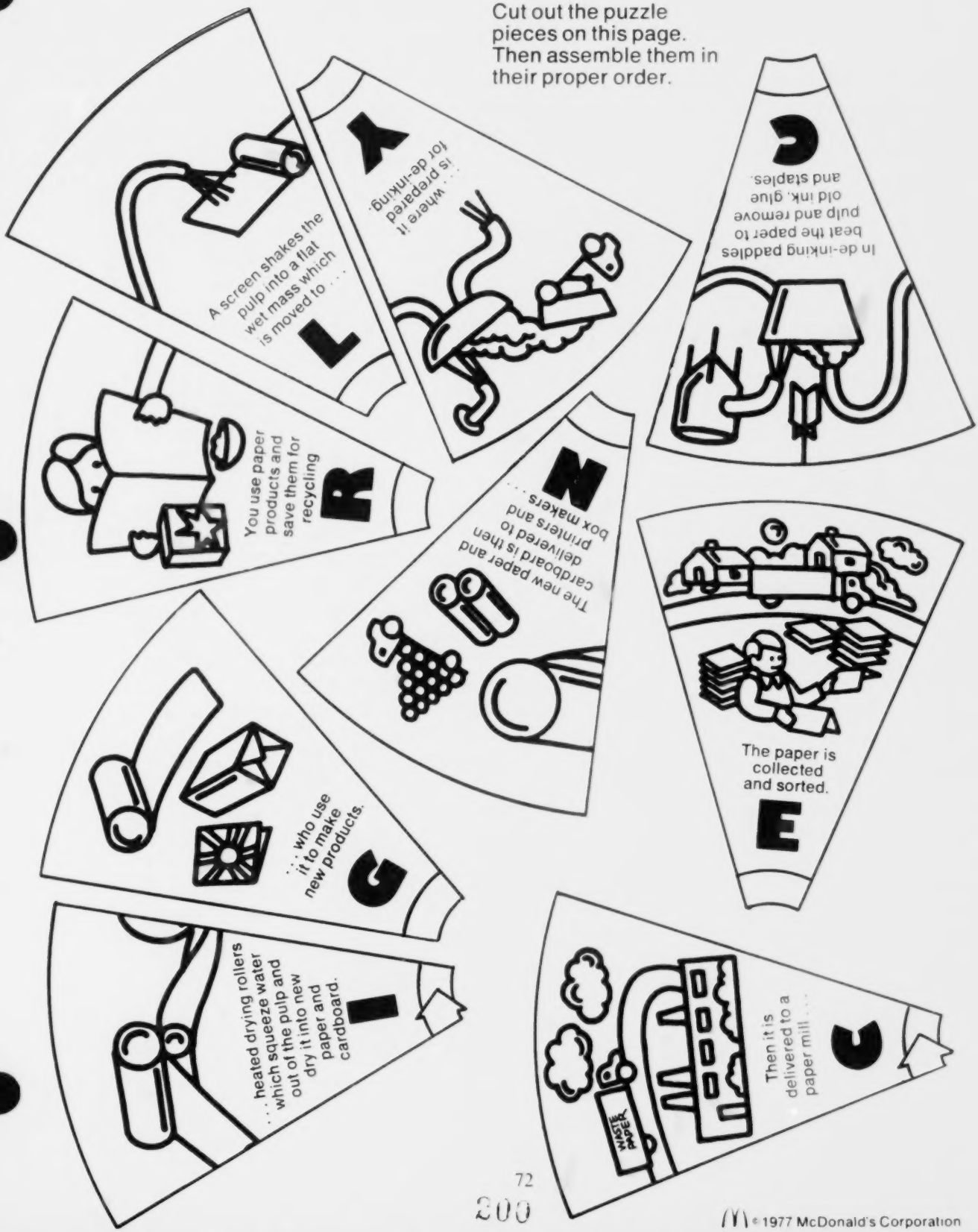
Help students to create a recycled paper cup in which they can plant a seedling. The cup can be planted in the ground where it will nourish the seedling as it decomposes. Follow the steps in papermaking, using two full pages of newspaper per planting cup. When pulp stage has been reached, have students mold the pulp inside a paper drinking cup. Instruct them to squeeze as much water as possible out of the pulp as they mold it. Allow it to dry totally – approximately three days. Upon drying, carefully peel off the original paper cup to reveal the fiber one. Plant seeds or a tree seedling in each cup, then place the cups in the ground. Allow students to observe and cultivate their plants noticing, over a period of time, the decomposition of the cups.

VOCABULARY

pulp
slurry
fiber

How paper is recycled

Cut out the puzzle pieces on this page. Then assemble them in their proper order.


A screen shakes the pulp into a flat wet mass which is moved to . . .
L
. . . where it is prepared for de-inking.
Y
In de-inking paddles beat the paper to pulp and remove old ink, glue and staples.
C
You use paper products and save them for recycling
R
The new paper and cardboard is then delivered to printers and box makers . . .
N
The paper is collected and sorted.
E
. . . who use it to make new products.
G
. . . heated drying rollers which squeeze water out of the pulp and dry it into new paper and cardboard.
I
WASTE PAPER
Then it is delivered to a paper mill . . .
C

200

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Lesson IV

WAITER, THERE'S SAND IN MY GLASS!

Reading and Creative Thinking

Students will read about the process of glassmaking and be able to identify the steps involved.

MATERIALS NEEDED

student reading sheet, student worksheet (one each per student)

BACKGROUND

To produce one ton of glass requires:

- 1330 pounds of sand
- 433 pounds of soda ash
- 433 pounds of limestone
- 151 pounds of feldspar
- 15.2 million BTUs of energy.

Pollutants generated include:

- 384 pounds of mining wastes
- 27.8 pounds of air pollutants

The use of 50% recycled glass in the manufacturing process:

- can reduce water consumption by 50%
- can reduce mining wastes by 79%
- can reduce air pollution by 14%

IMPLEMENTATION

Explain to students that because glass can easily be reused, the recycling market for glass remains fairly stable. A nearby company in Dayville, Connecticut, Diamond-Bathurst, Inc., has been operating with recycled glass cullet for 16 years. They produce 600 tons of glass per day, with 50 - 80% of their batches being comprised of recycled glass. Drinking glasses, liquor bottles, Pepsi and Veryfine Apple Juice bottles are among their products.

In order for glass to be easily recycled, any metal rings must be removed and the glass must be sorted by color. Some plants have machines which are capable of doing this automatically. Paper labels will easily disintegrate in the superheated furnaces required to melt glass.

Distribute student reading sheet and worksheet. Have students work independently, and then display drawings to the group to determine their identities. Instruct students to take their drawings home to compare with actual items, and, on another sheet of paper, to trace the original glass container. Have students construct flow charts or sequential illustrations to display the steps involved in making glass. Conduct a letter writing campaign inquiring why manufacturers don't use glass anymore. Write to recycled glass dealers inquiring about the products made from recycled glass so we can choose them over containers that will not be recycled.

EXTENSION

Tell students that in 1981, 3 billion glass containers were recycled in the U.S. While that figure may sound large, encourage them to compare it to production (80 million /day x 250 workdays = 20 billion). The 3 billion containers represented 1,604,000,000 pounds. Also, help them to determine the average weight per container (1,604,000,000 divided by 3,000,000,000 = .532 pounds) and to estimate the weight of 20 billion containers (approximately 7 times 1.6 billion pounds = 11.2 billion pounds which were thrown away).

VOCABULARY

cullet
silica

WAITER, THERE'S SAND IN MY GLASS!!

Glass bottles have been in use for a long time. Four thousand years ago, the Egyptians used them. Americans have produced glass since the time of the Pilgrims. Why is glass so popular? The materials are easy to get and the containers can be used in many different ways.

Silica (which is sand), limestone and soda ash are needed to make glass. Silica is the most common substance in the earth's crust. It is a non-renewable resource, but still quite plentiful.

These ingredients are mixed to make a "batch" of glass. Pieces of recycled glass, called cullet, can be mixed in. The batch rides to a very hot furnace on belts or in buckets. It is fed into the 2,700° furnace by machine. The mixture melts, bubbles, and boils. It's so hot that a bright white glow results. Workers must wear dark glasses to protect themselves from the glare.

When the batch is completely melted, it flows through a skimmer. There it is refined and moves to an automatic feeder. Hot "gobs" are dropped into a mold. Compressed air blows it into the bottle's final shape. This formation takes just 13 seconds! A conveyor belt then moves the bottles slowly through a cooling tunnel. In about an hour, the bottles are cool enough to touch. This slow cooling, plus a protective coating, strengthens the glass. Then the bottles can be filled and labeled. They are ready to go to the store for you to buy. In the U.S., 80 million bottles are made daily.

What happens when you are finished with the bottle? You *could* throw it away. You'd be wasting all the natural resources and energy that went into making it, though. You could recycle it. Then the glass could be remelted and used again. Eighty-three percent of a new batch of glass can be made up of recycled glass. The used glass could be mixed with asphalt to make roads. It can even be used in building materials, sewer pipes, jewelry and chicken grit!

Recycling the glass is smart for lots of reasons. Natural resources are saved. Energy is saved because a batch with recycled glass will melt at a lower temperature. Part of our solid waste problem is solved. Instead of lying in a landfill for thousands of years, the bottles will be useful over and over again!

NAME_____

Many of the things you use in your home are made of glass. Think for a few moments until you can picture one glass container in your mind. Think carefully about its size and shape. Draw it below. Challenge your classmates to identify it. Then, at home, compare your drawing to the real thing.

Lesson V

ONCE IS NOT ENOUGH

Art/Reading Activity

Students will be able to explain to their peers the benefits of recycling aluminum cans.

MATERIALS NEEDED

large drawing paper or craft paper, painting materials, string, aluminum beverage cans (one per student), student worksheet, (one per student)

BACKGROUND

To produce one ton of aluminum requires:

- 8,766 pounds of bauxite
- 1,020 pounds of petroleum coke
- 966 pounds of soda ash
- 327 pounds of pitch
- 238 pounds of lime
- 197 million BTUs of energy

Pollutants generated include:

- 3290 pounds of red mud
- 2900 pounds of carbon dioxide
- 81 pounds of air pollutants
- 789 pounds of solid wastes

Recycling of aluminum (rather than new production) can reduce energy use by 95% with similar reductions in water and air pollution.

To produce one ton of steel requires:

- 1970 pounds of iron ore
- 791 pounds of coke
- 454 pounds of lime
- 29 million BTUs of energy

Pollutants produced include:

- 538 pounds of solid wastes
- 242 pounds of air pollutants

Recycling of steel can reduce energy consumption by 74%, with an 86% reduction in air pollutants, 40% reduction in water use, 76% reduction in water pollutants and 97% reduction in mining wastes.

Our metal discards have been referred to as "mines above ground" because the metal found in cans, automobiles, refrigerators, stoves, steel beams, car radiators etc., has already been through the costly extraction process. It has the potential to be remelted or detinned and used over and over again, without further withdrawals from the supply still left in the earth.

When 1000 tons of steel are made with scrap, the energy saved is the equivalent of 140,000 gallons of gasoline! It also requires 8,500 fewer kilowatt hours of energy to produce one ton of steel from automobile scrap than to use iron ore. That's enough energy to supply the electrical needs of an American family for almost a year! One-and-one-half tons of iron ore and one-third ton of coal/coke are saved with each ton of scrap metal used.

In spite of these savings, there has not been sufficient economic incentive for metal manufacturers to use recycled steel. An increased, steady supply (from states committed to recycling) and a demonstrated effort by concerned citizens who are no longer willing to waste our precious metals should serve to boost this market considerably.

IMPLEMENTATION

You may wish to have students experiment with and differentiate between cans of different metals, in which case you could share the following information or encourage students to create their own charts through careful observation.

ALUMINUM CANS (soda) – not attracted to magnet; almost all say "All Aluminum" on the side; no seam; bottom is round and somewhat shiny; can is shiny, silver, smooth; lightweight; finely brushed on the bottom; printing is directly on the can rather than on a paper label

BIMETAL (small juice cans, tuna fish cans, tennis ball cans) – not attacted by magnet; bottom has a rim; bottom is not finely brushed; usually spray painted; may or may not have a seam

TINNED (soup cans) – is attacted by magnet; always has a seam; heavier in weight than aluminum; usually has rings or ribbing on the can; normally has a paper label

Explain to students that aluminum cans are easily recycled. The aluminum itself is a valuable commodity and can be reused over and over again. Some can manufacturers have been involved in buying used aluminum for many years because of the savings in raw materials and energy for processing. Some communities (North Kingstown, R.I. is one) have "Can Banks" – reverse vending machines – where a consumer inserts empty cans and receives payment. Civic groups have collected aluminum cans in order to realize the profit (1986 prices – 24 cents per pound with 23 cans per pound). In Rhode Island, cans will be collected with other recyclables for processing and sale.

Distribute student reading sheet. Help students to identify four benefits of recycling aluminum (saving energy, saving natural resources, profit, and less destruction of the earth through mining). Ask if students have previously recycled cans and if, now that they know the benefits, they would be inclined to do so.

Distribute painting materials, two large sheets of drawing paper per student and aluminum beverage cans. Paper should be large enough so that students can wear their completed cans as signs or sandwich boards. Instruct students to study the design and words on the can carefully and to paint them on the paper, the front of the can on one sheet and the back on the other.

When the paint has dried, have students model their cans (with string attaching the papers at the shoulder) and prepare a one minute talk on the benefits of recycling aluminum cans. Help the class to choose the five best "cans" to deliver the recycling message to five other classes.

EXTENSION

Encourage students to begin a can recycling project at school if your city has not yet begun participation in the mandatory recycling program. For assistance, contact OSCAR concerning the "I *CAN* RECYCLE" program. Prepare a storage area in the classroom and contact a local recycling center for redemption. A list of recycling centers is available from OSCAR.

To increase storage capacity, students may create a can crusher by attaching two one-foot lengths of 2 x 4 with a hinge.

Challenge another class in your school to a contest to see which class can accumulate the greatest number of cans for recycling. Plan an activity to share the profits.

VOCABULARY

bimetal
tinned
aluminum
alloy
flux

I *CAN* RECYCLE

EXETER – Wawaloam Elementary School set a recycling record as second and third graders participated in an aluminum can recycling project under the direction of physical education teacher, Donna Calore. OSCAR the Seagull visited the school to launch the project by showing a film on recycling and handing out litter bags, buttons and bumper stickers.

The competition between the two grade levels was intense. Parents and children scoured woods and roadsides and placed recycling receptacles in local restaurants and businesses. One recycling bag even ended up in the office of Governor DiPrete, whose staff was happy to assist. At the conclusion of the project, the second grade had collected 56,819 cans and the third grade won with a can total of 70,563.

The Association of Parents and Teachers agreed to match, dollar for dollar, the amount of money raised by selling the cans to a recycling center. The 127,382 cans provided revenue of $1,158.68. With the matching funds, the total raised was $2,317.36 which will be spent on new playground equipment.

from OSCAR'S CALL, September, 1986

ONCE IS NOT ENOUGH!

An aluminum can, left outside, will not just disappear. It will take the sun, wind and rain 500 years or more to break it down into dust. Why? Why is aluminum so long-lasting? Its chemical composition protects it. This is helpful as long as the item is being used. But even when we are finished with it, the can lasts for a long time.

Aluminum is made by mining bauxite and mixing it with other alloys. It is useful when a lightweight yet strong material is needed. Many aircraft materials are aluminum. So are beverage cans, pie plates, frozen food trays, and foil. Building materials like siding, gutters, and window frames are also aluminum. They can all be recycled.

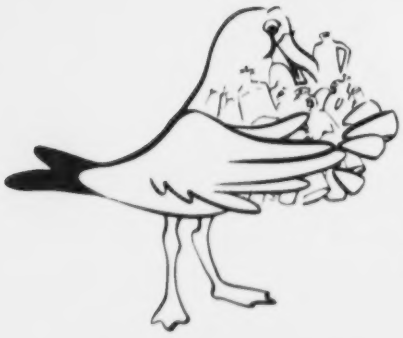
Recycling saves the natural resources used to make the end product. It saves energy – 20 recycled cans can be made using the same energy as one new can. It saves the earth, which must be mined to take out the bauxite. And it saves money.

In 1985, Rhode Islanders threw away $2,000,000 in aluminum cans which could have been recycled! Some towns and cities require people to recycle cans. Some civic groups collect them. In each case, the cans are worth money. Can dealers pay by the pound for the cans brought in. It takes about 23 twelve-ounce aluminum cans to make one pound.

Not all cans are aluminum. How can you tell which ones are? They don't have side seams, they won't stick to a magnet, they are lightweight and easy to crush.

When cans are recycled, they follow a circular path. First, magnets remove any steel cans accidentally mixed in. Then the cans are flattened and shredded into pellets or baled. Next, the aluminum goes to a smelting plant where it is melted. Furnaces melt the aluminum with flux for 18 hours to skim off impurities. Then it is poured into molds and cooled. Next it goes to a manufacturer who can hot-roll it into strip aluminum to form more cans. The cans are filled, sold and the contents consumed. Then they can be recycled – again and again.

Nationwide, we now recycle over half of all the aluminum cans we use. Are you doing your part?



Lesson VI

92 POUNDS OF TROUBLE

Reading/Critical Thinking Activity

Students will recognize that the variety of plastic materials in use presents a major obstacle to recycling.

MATERIALS NEEDED

An assortment of plastic bottles (three per student, minimum), student worksheet (one per student)

BACKGROUND

In the past decade, waste plastics have doubled in the United States. Eleven million tons (that's 22 BILLION pounds!) go into our national trash heap. In New England, our share is one billion pounds – most of which will remain in our landfills virtually forever.

Eighty percent of all plastics now in use fall into the category of thermoplastics, which can be remelted and reformed somewhat like ice cubes can be melted and then refrozen. The remaining 20%, thermosetting plastics, cannot be reformed at all.

In 1984, an estimated 17 billion plastic bottles were produced. Approximately 40% of the plastic bottles are either soft drink bottles (whose chemical composition is referred to as PET) or milk bottles (made from a different plastic, HDPE). These bottles are the most easily recycled because there is a large quantity of each type available. Other plastic bottles (picture the variety of dishwashing soap or shampoo bottles) can only be recycled with matching plastics, as different polymers do not adhere to one another. This makes their recovery through recycling close to impossible.

As in other recycling efforts, the savings in resources through recycling plastics is significant. Plastics are part of the petrochemical industry, and the natural gas and crude oil used to make them are nonrenewable resources. Producing plastic from scrap (recycled) plastic saves 85-90% of the energy used in forming items from new materials. Incinerating plastics results in a 60-90% energy loss (some is saved in heat as the plastic burns), and the incinerator must then be cleaned out to neutralize the acid emissions. Problems with acid emissions and dioxin threaten another important resource, clean air.

IMPLEMENTATION

Have each student bring in three plastic items from home. Note the wide variety of items which fall under the category of "plastic". Explain to students that each different plastic is made of a different chemical material. Lead students to recognize that each type of plastic can therefore only be recycled with plastics of a similar chemical makeup. Discuss the problems of plastics and their disposal. Challenge students to brainstorm alternative/innovative solutions to this dilemma.

Have students read and discuss the information sheet. Then divide the class into small groups with a variety of plastic bottles (a three bottle per student ratio or greater is recommended). Assign students the task of finding five different ways to group or classify the bottles assigned to their group. Function, color, shape, type of opening are all possible ways – you may need to suggest a few, and have students go through physically regrouping the bottles before they understand the process. Have each group keep notes on the various kinds of groups they have formed, then share them with the class. Combine bottles from all groups and have students determine new classifications.

EXTENSION

Weigh (or try to balance) several containers which hold the same volume, to compare their densities. Fill them with water and compare how they float, if a large sink is available.

VOCABULARY

PET
HDPE
petrochemical
dioxin
polymer

NINETY-TWO POUNDS OF TROUBLE

Plastics have changed our way of life. Each year, items once available in glass or paper appear in new plastic packaging. Is this good news or bad?

The good news is that plastic really does have a lot of advantages. It is flexible and strong. It won't break when you drop the bottle with soapy hands. It can be shaped and colored in many different ways. The cost to manufacture it is fairly low.

What, then, is the bad news? As of 1986, Americans were throwing away 92 pounds of plastic per person each year! That means that the raw materials and the energy needed to make the plastics are wasted. Since plastic is permanent, it will stay in a landfill forever.

What should we do? Here are four possible answers: ban, biodegrade, bury and burn. But banning plastic won't work. We like its convenience. Very few plastics now made will biodegrade. To bury the plastic in a landfill takes up too much space. Some people think that burning plastics in an incinerator is the best idea. Plastics do help all the other types of solid waste to burn better. But, 60 - 90% of the energy used to make plastic is still lost. Also, the air released from burning may be harmful to our health.

As you may have guessed, recycling is the best ending to the life of a plastic bottle. There are many different kinds of plastic in use. Thus, there are some problems. Only plastics whose chemical makeup is the same can be recycled together. Milk bottles are made of a chemical known as HDPE. Soda bottles are formed from another plastic known as PET. The two plastics can't be mixed. Sorting and separating plastics first, and then recycling them makes sense. We can save energy, resources and money. More than $20 billion could be saved each year if we recycled all waste plastics.

Recycled bottles are compacted into bales, shredded into strips, or ground into small flakes. Then they are hauled away to be reformed. Such plastics are now used in fiberfill (for jackets, sleeping bags, and pillows), car seats, straps for movers, wall tile, toys, and scrub pads. Some plastics can be reformed into fiberglass tubs, showers, boat hulls and swimming pools. A new type of "plastic lumber" is now being used in some construction projects.

Using plastics may be a habit that's hard to break. We need to form the recycling habit as well. Then the cost, to our environment and ourselves, will be much less.

Lesson VII

THE CHOICE IS *CLEAR*

Math Activity (Graphing)

Students will create bar graphs to compare different beverage containers and determine which are the most ecologically sound.

MATERIALS NEEDED

Student worksheet (one per student)

IMPLEMENTATION

Review with students the reasons why recycling is a wise environmental practice.

Distribute student worksheet and assist students in reading the chart to compare different beverage containers according to the criteria listed.

Instruct students in the formation of a bar graph to compare the energy consumed in producing each type of container. Demonstrate how to label the vertical and horizontal sides, and explain the importance of a title on the graph so that others will know what is being displayed.

Have students complete five more bar graphs independently to demonstrate how each container compares according to the various criteria.

Discuss with students which containers appear to be the best and worst environmental choices. Explain that by recycling the steel, 60-70% of the energy is saved. Recycling the aluminum saves 90-95% of the energy. This is, of course, completely lost by using such containers only one time.

EXTENSION

Urge students to identify and carry out methods to influence either manufacturers or consumers in making better choices regarding beverage containers.

SOURCE

Statistics are from *Resource and Environmental Profile Analysis of Nine Beverage Container Alternatives*, U.S. EPA; *Garbage Reincarnation*

THE CHOICE IS *CLEAR*

Your parents and grandparents may well remember when milk and soda came in glass bottles. The empty bottles were returned to the store. When the store collected enough bottles, they were trucked back to the bottling company. Sterilization guaranteed there would be no germs left on the bottles. Then each bottle was refilled and sent back to the store. Some bottles made this trip as many as 20 times. When the bottle broke or became too badly scratched, the glass was melted down and reformed.

In the 1970s, things began to change. Milk started appearing on grocery store shelves in wax cartons and plastic jugs. The soda industry switched to plastic containers. Businesses made this choice based on cost. They found it cheaper to make millions of plastic bottles than to reuse glass ones. Perhaps, for the manufacturer, it does cost less. But what about us? We pay for this through energy and water consumed. Air pollution and increased solid wastes are also part of our cost.

STUDY THE CHART BELOW.
USE THE INFORMATION TO CREATE SIX BAR GRAPHS.

CONTAINER COSTS FOR 1000 GALLONS OF SODA

Times used	GLASS 19x	GLASS 1x	ALUMINUM 1x	PLASTIC 1x	STEEL 1x
Energy (10^6 BTU)	15.90	64.38	75.61	63.33	38.83
Water (1000 gal)	11.35	38.94	15.17	41.71	39.01
Industrial Solid Waste (cu.ft.)	6.59	38.46	36.13	7.21	108.00
Atmospheric Emissions (lbs.)	70.52	261.01	323.02	240.07	145.08
Waterborne Wastes (lbs.)	27.43	56.46	69.00	68.79	18.14
Post Consumer Solid Waste (cu.ft.)	7.16	40.97	2.07	27.05	3.49

PASS IT ON: UNIT EVALUATION

Tell students that they have become educated consumers in terms of recycling, but that people not using OSCAR'S OPTIONS may not be aware of the need to recycle, the benefits of recycling or the laws governing recyclable materials.

Have students plan a way to share what they have learned with other community members. Class books, posters, a recycling fair, a slide show or videotape are all possible methods. This step is an important extension in bringing the message of OSCAR'S OPTIONS to the community at large.

Support materials are available from the Department of Environmental Management's OSCAR program. Oscar the Seagull may also be able to visit your event.

EXTENSION
word search

WORD SEARCH – things that can be recycled

D E A G N C O N C R E T E P T

R M O T O R O I L S F Q S I C

U W F Z K L U O T N X S R H O

V L F C J Z D G W A I E T D R

R T I N C A N S L C S I A A R

E S C O P P E R N M M B C E U

P H E G X O Z O W U E V L L G

A D P A P E R S Q N T A T L A

P L A S T I C S W I A J L Z T

S T P I Z U H T O M L M A W E

W B E C U B D E O U S I H R D

E G R A G S T E D L N D P Z S

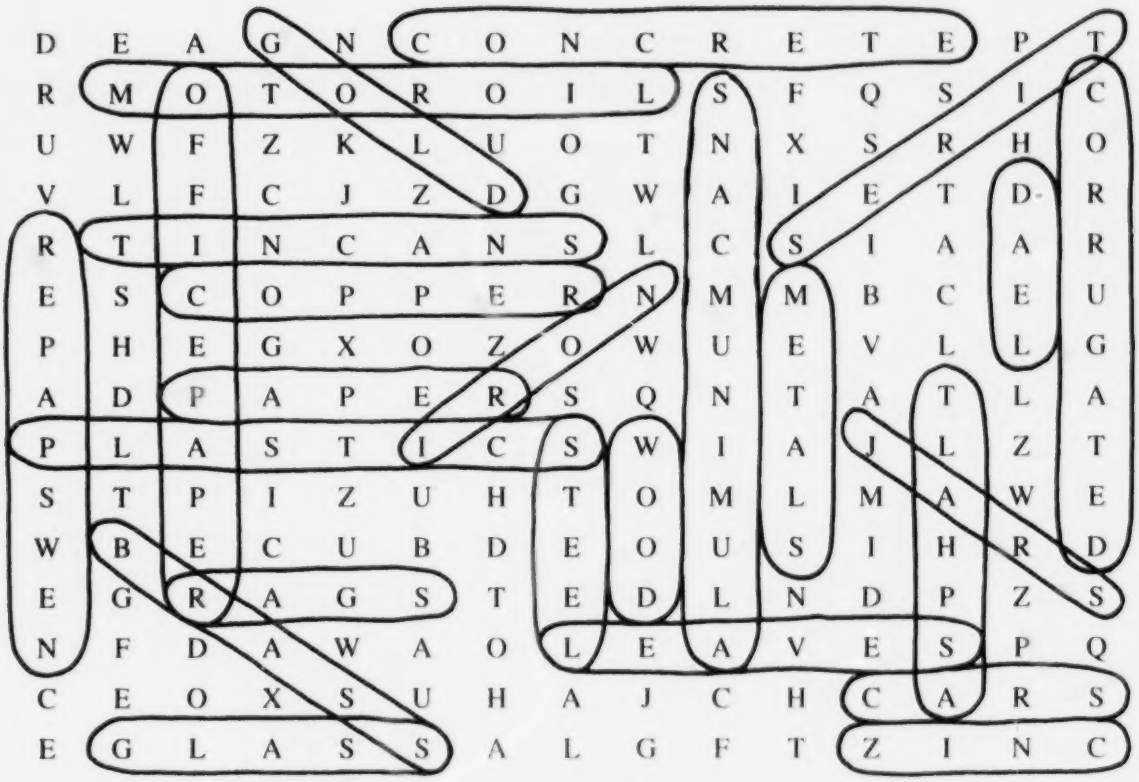
N F D A W A O L E A V E S P Q

C E O X S U H A J C H C A R S

E G L A S S A L G F T Z I N C

Teacher's Page

WORD SEARCH – things that can be recycled


D E A G N C O N C R E T E P T
R M O T O R O I L S F Q S I C
U W F Z K L U O T N X S R H O
V L F C J Z D G W A I E T D R
R T I N C A N S L C S I A A R
E S C O P P E R N M M B C E U
P H E G X O Z O W U E V L L G
A D P A P E R S Q N T A T L A
P L A S T I C S W I A J L Z T
S T P I Z U H T O M L M A W E
W B E C U B D E O U S I H R D
E G R A G S T E D L N D P Z S
N F D A W A O L E A V E S P Q
C E O X S U H A J C H C A R S
E G L A S S A L G F T Z I N C

Horizontal: concrete, motor oil, tincans, copper, paper, plastics, rags, leaves, cars, zinc, glass

Vertical: newspaper, officepaper, steel, wood, aluminumcans, metals, asphalt, lead, corrugated

Diagonal: gold, iron, tires, brass, jars

NOTE: YOU MAY WISH TO PROVIDE YOUR STUDENTS WITH A GENERAL LIST OF WORDS FOUND WITHIN THE WORDSEARCH IN ORDER TO MAKE THEIR TASK EASIER.

RECYCLING

VOCABULARY

aluminum – a strong, light, silver-colored metal made chiefly from bauxite ore

bimetal – container made from two metals, usually steel and aluminum

biodegradable – able to break down naturally

cullet – scrap glass broken into small pieces

cycle – a continuous process

decay – to break down over time

dioxin – a toxic chemical

erode – to wear away or decay

evaporate – to change into vapor or gas

fiber – thread that gives texture or substance to paper or fabric

glass – a transparent inorganic material produced by melting almost pure silica sand with burnt lime or limestone, with soda ash added to give hardness and chemical durability.

glasphalt – a highway paving material in which recovered ground glass replaces gravel in asphalt

HDPE – the common name for the chemical composition of plastic milk bottles

minerals – any of various naturally occurring substances (stone, coal, salt, sulfur, sand, petroleum, water or natural gas) obtained from the earth

MRF-Materials Recovery Facility – a location where waste materials are separated and processed to be sold for various purposes

nutrients – materials contained in the soil which enrich it, providing for plant growth

PET – the common name for the chemical composition of plastic soda containers

petrochemical – a chemical made from petroleum or natural gas

photosynthesis – the process by which plants manufacture food through the use of sunlight

pulp – fiber material from which paper and paperboard are made

recyclables – includes almost all natural and some manmade materials, most commonly glass, aluminum, newspaper, cardboard, tin, plastic and oil

recycling – to use something over again, often by collecting and processing a waste product for use as a raw material in the manufacture of the same product or a similar one

sediment – the matter which settles to the bottom of a liquid

silica – sand

slurry – a thick watery mixture

tinned – covered with a thin layer of tin

tipping fee – the amount charged for a truck, person or town to dispose of solid waste at a landfill

RECYCLING

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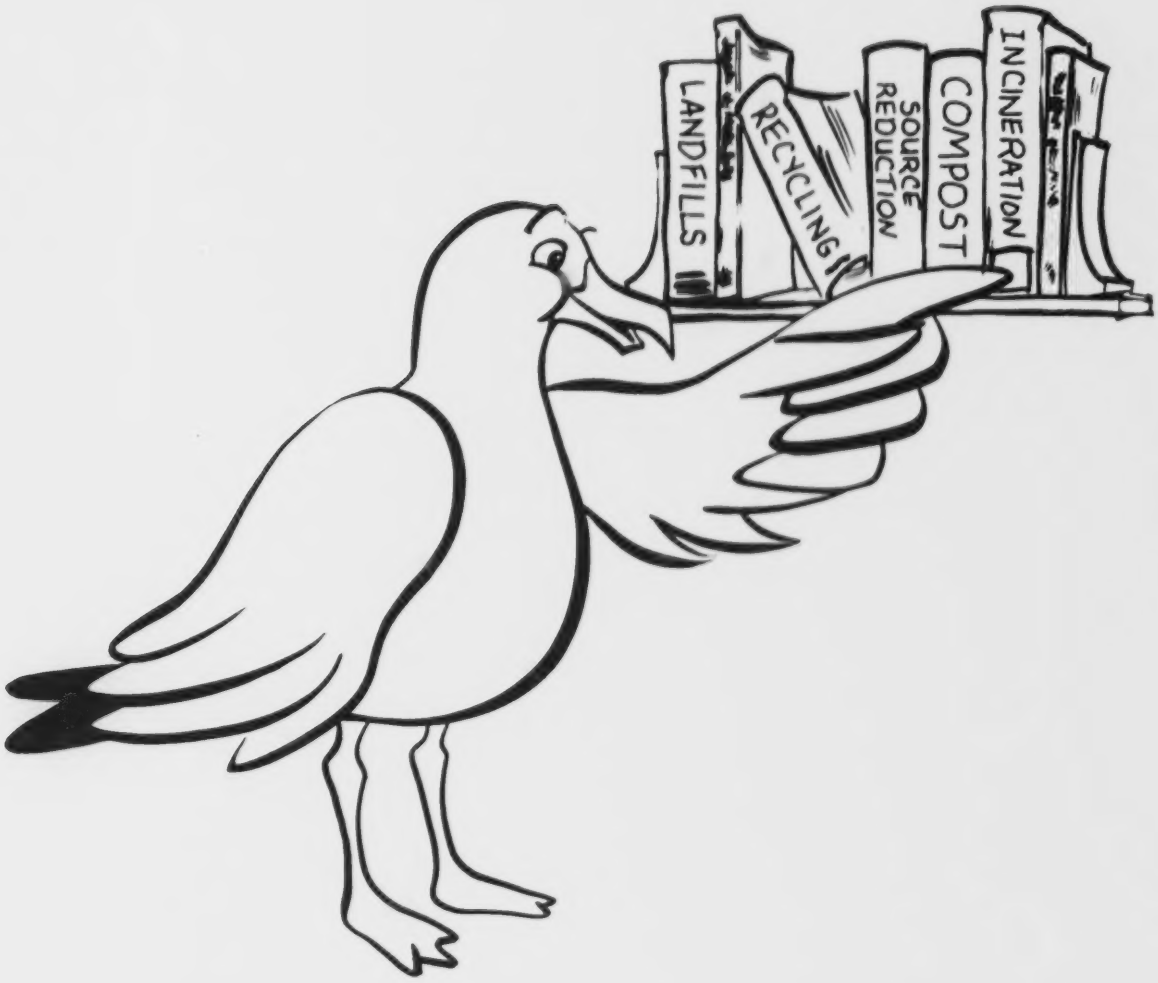
OSCAR'S OPTIONS
UNIT VI
INCINERATION



INCINERATION

Introduction

Incinerate means to burn to ashes. An incinerator is a complex container in which waste materials are burned to reduce their volume. Since landfills are no longer regarded as an environmentally sound method for solid waste disposal, incineration is the new technology of choice for solving a portion of our solid waste problem.

Incineration combined with recycling can result in reduction of the volume of solid waste. As much as 90% of our waste may be burned or recycled. In addition, the heat produced by the burning waste may be used to generate electricity which is sold to reduce disposal costs. This combination of incineration and a heat recovery system is known as resource recovery. Extracting valuable natural resources from solid waste is a sound environmental practice, so this conversion of waste to energy is an important aspect of the state's solid waste plan.

Mass-burn systems incinerate the solid waste as it is received at the facility, without pre-processing. This technology has been used with great success in Europe and Asia for many years. More recently, mass-burn technology has shown success throughout the United States. Historically, mass-burn incinerators have not experienced the mechanical problems, explosions and shutdowns associated with other technologies. The Solid Waste Management Corporation intends to build three mass-burn, resource recovery facilities, to be located at Quonset Point/Davisville Industrial Park in North Kingstown, the Central Landfill in Johnston and a site to be determined in northern Rhode Island. Up to 710 tons of source-separated waste from Rhode Island homes and businesses will be processed at each of these facilities. Each facility produces the energy equivalent of 45,000 gallons of #2 fuel oil daily, generating enough electricity for approximately 7,500 Rhode Island homes.

From an environmental standpoint, the advantages of resource recovery are that it protects ground and drinking water sources from contamination and conserves our valuable land space. There are fewer aesthetic problems associated with the siting of a resource recovery facility. Because waste is deposited inside a fully enclosed structure, problems such as odor and rodent, bird and insect infestations are minimized. However, truck traffic and associated noise and litter are comparable to that at a landfill.

The major concern about resource recovery as a solid waste option is air pollution. Many people are particularly fearful of the effects of burning the increasing quantities of plastics found in the waste stream. Of particular concern are emissions containing the class of organic compounds called polychlorinated dibenzo-p-dioxins (PCDDs). There are 73 different kinds of PCDDs, the most toxic of which is 2,3,7,8 tetrachlorodibenzo-p-dioxin. The acute effects of PCDDs on laboratory animals are well-documented. Chronic exposure leads to liver and thymus dysfunction in mice and rats. Cleft palate and cystic kidneys are teratogenic effects observed in mice. In addition, dioxin is carcinogenic in these same laboratory animals. Human epidemiological studies have not yet yielded definitive results on long-term effects of low level exposure. Human exposure in several well-documented

chemical accidents resulted in chloracne, liver dysfunction and disorders of fat and carbohydrate metabolism as well as problems with the cardiovascular, urinary, respiratory and pancreatic systems. Interestingly, these non-lethal effects appear to be reversible. Other plastics, such as polyethylene, are made up of carbon and hydrogen and do not contain the chlorine compounds implicated in dioxin formation.

Epidemiological evidence has not established a link between dioxin emission and cancer or other serious illness in humans. Despite a wealth of research in recent years, a dioxin risk assessment drafted for the Essex County Resource Recovery Facility, based on exposure of 24 hours per day for 70 years, concluded that ". . . the risks of contracting cancer . . . for American emission rates for worst case exposure over a lifetime will increase from the current 200,000 per million to 200,000.8 per million population." While dioxin emission is a side effect of waste combustion, the amount appears to be low and available evidence indicates that dioxin does not present an unacceptable public health risk.

Nonetheless, Rhode Island has established strict guidelines to control and monitor emissions from the resource recovery facilities. These guidelines have been developed by the Department of Environmental Management, assisted by an advisory committee representing Save the Bay, The RI Lung Association, the Audubon Society, URI, CONCERN and the towns of Johnston, Woonsocket, and North Kingstown. Rhode Island's policy sets stringent emission limits.

The first resource recovery plant, to be built at Quonset Point, will be equipped with state-of-the-art pollution control devices to safely and effectively control emissions of dioxin, acid gas, and particulate matter, which are formed when trash is burned. These control devices consist of dry scrubbers and baghouses. After combustion, flue gases from the boiler pass through a dry scrubber where they are treated with a fine, lime-based spray to remove acid gases. Next, a fabric filter baghouse works like a vacuum cleaner bag to trap any remaining dust and particles. Then clean gases are exhausted through the tall stack. There will be no visible stack emissions.

The toxic fly ash collected from the baghouse and the non-combustible residue or bottom ash from the furnace (approximately 25 percent of the original volume of the solid waste) will be disposed of at the Central Landfill. The Landfill will receive approximately 600 tons per day, as compared to the current 3,500-4,000 tons per day, when all three facilities are fully functional. Because of the presence of toxic metals and organics in the ash, the Environmental Protection Agency's extraction procedure toxicity test will be used to classify the material before disposal. Some regulatory agencies require that the disposable matter from the waste combustion process be placed in a specially lined or hazardous waste landfill.

While the environmental concerns cannot and should not be minimized, the reality of 4,000 tons of waste per day cannot be ignored. If landfilling is no longer an alternative, then we must accept the fact that resource recovery is both viable and necessary. According to Thomas Wright, Director of the Solid Waste Management Coroporation, "modern resource recovery facilities and recycling programs offer us numerous opportunities to recover the energy and resources contained in trash. Combined, they are the most environmentally safe and responsible alternatives to land disposal."

INCINERATION

OBJECTIVES

1. Students will understand the differences between incineration and resource recovery, recognizing the advantages and disadvantages of incineration as a waste disposal option.

2. Students will observe how incineration reduces waste and produces emissions.

3. Students will examine a complex social, economic and environmental problem to determine the advantages and disadvantages for the community.

INCINERATION

ACTIVITIES

I.	Burn It Up!	Language Arts and Science
II.	Garbage to Ashes	Science and Math
III.	Not In My Backyard	Social Studies and Science

INCINERATION

TEACHER INFORMATION

These lessons were written with grades 4-8 in mind. All student materials are written at a 6th grade reading level. The lessons within the unit are arranged sequentially, but individual lesons may be taught or deleted as best suits you and your class.

POSSIBLE IMPLEMENTATION OF INCINERATION UNIT

Monday	I.	Language Arts Science	30 min. 30 min.
Tuesday	II.	Science and Math	45 min.
Wednesday Thursday Friday	III.	Social Studies & Science	Teacher Discretion

Lesson I

BURN IT UP!

Language Arts, Science

Students will understand the differences between incineration and resource recovery, recognizing the advantages and disadvantages of incineration as a waste disposal option.

MATERIALS NEEDED

Student reading sheet, student worksheet (one each per pupil)

IMPLEMENTATION

Distribute student reading sheet and allow time to read and discuss the information. Help students to understand that the incinerator will greatly reduce the amount of solid waste but will create concerns about various kinds of pollution. Emphasize the difference between incineration and resource recovery. Lead students to recognize that all the choices for waste disposal have advantages and disadvantages. It is up to us, individually and as a society, to weigh the alternatives and make the best possible choices. Distribute Resource Recovery Facility worksheet. Since the vocabulary accompanying the diagram is quite difficult, it is suggested that you use the transparency and work as a class, tracing the truckload of waste as it is processed through the facility.

VOCABULARY

incinerate
incinerator
energy
resource recovery
emissions
pollution
solid waste
landfill
dioxin

BURN IT UP!

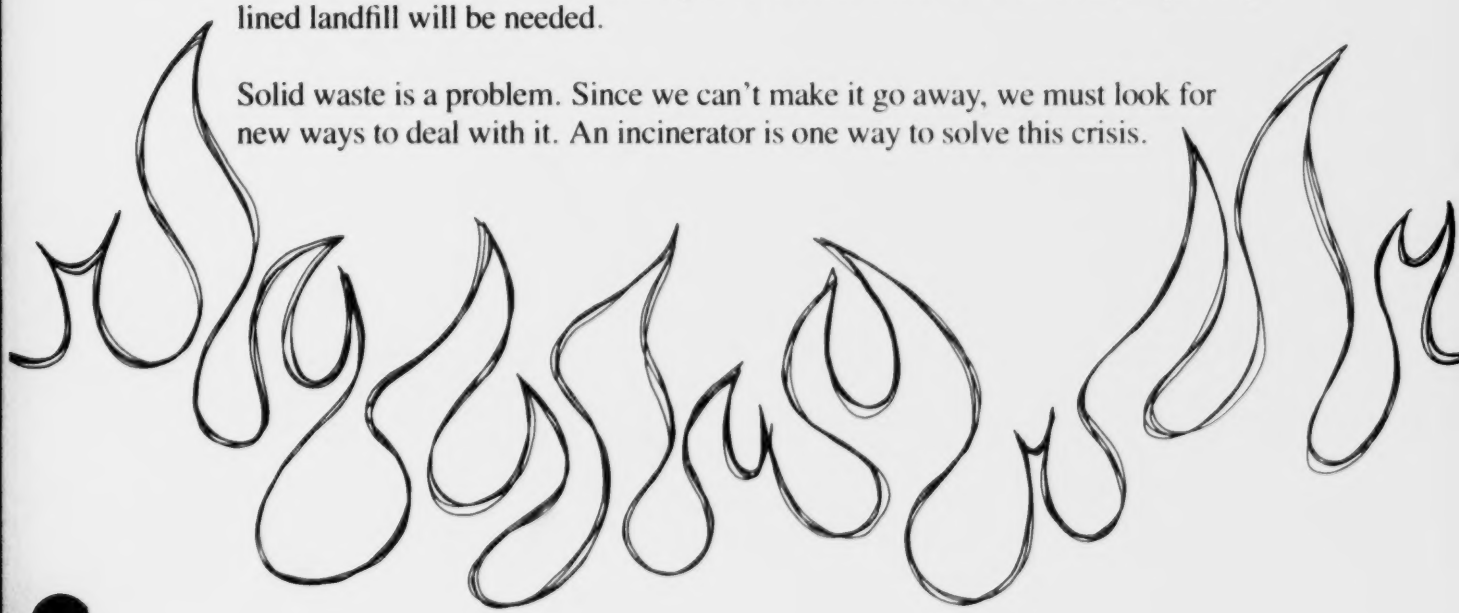
Incinerate means to burn to ashes. The burning takes place in a container called an incinerator. When waste is burned, there is less waste. If we cannot use landfills for our solid waste, we need to find a new disposal method. Incineration may be a way to solve the problem.

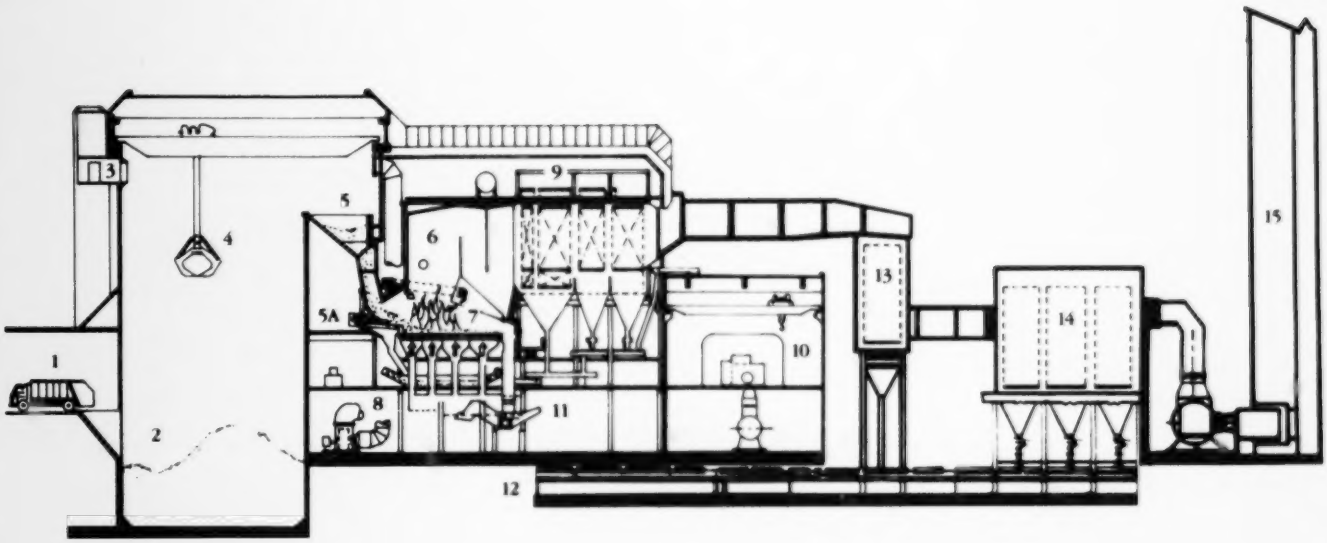
Burning waste creates heat which may be used to produce steam. The steam can generate electricity for homes and businesses. Burning waste to produce energy is known as resource recovery.

Resource recovery protects ground and drinking water and saves valuable land space. Since the waste is inside a building, there is less odor. Fewer rats, birds, and insects are attracted to the waste. But, the truck traffic, dust and noise are the same as at a landfill.

Two problems, air pollution and ash disposal, cause concern for some people. They worry that emissions from the incinerator may pollute the air. These gases might cause health problems for people who live nearby. The chemical dioxin is a particular problem. Pollution control devices must be used to make the air safer. Ash from the incinerator may also contain toxic materials. So, a specially lined landfill will be needed.

Solid waste is a problem. Since we can't make it go away, we must look for new ways to deal with it. An incinerator is one way to solve this crisis.





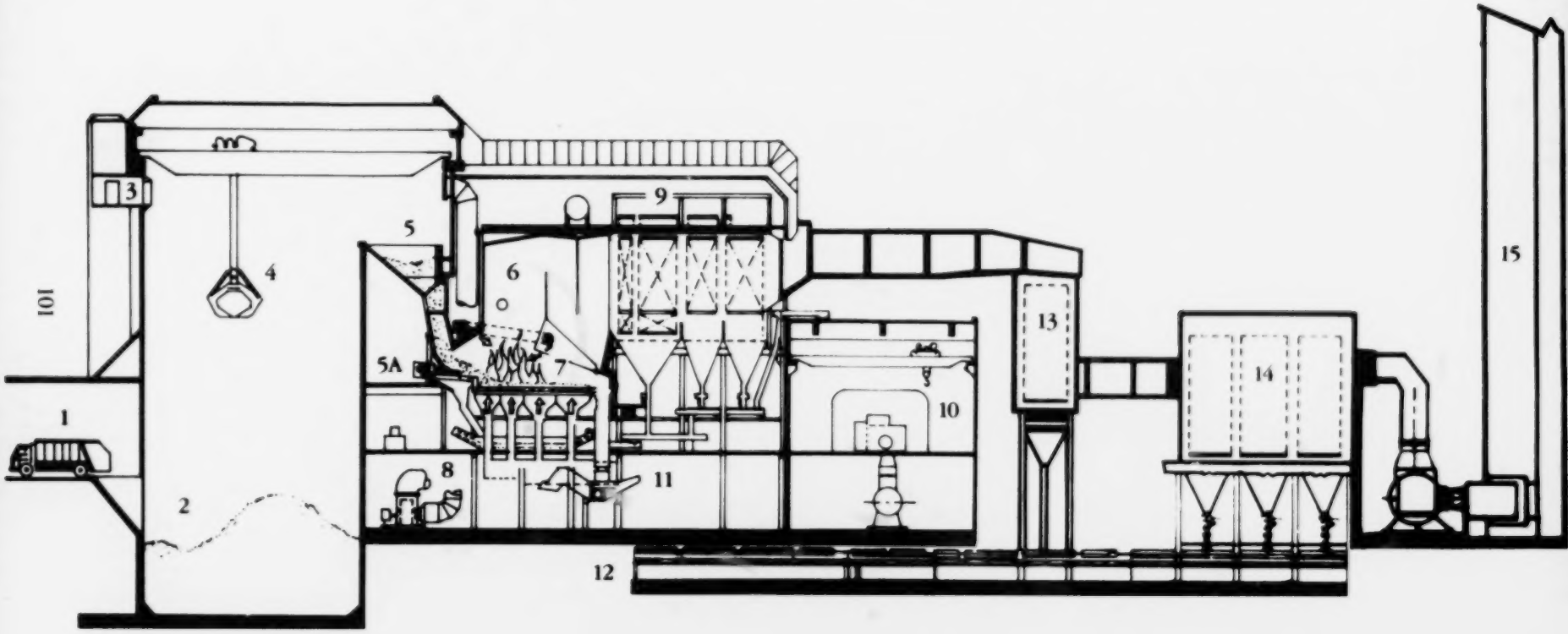
RHODE ISLAND'S RESOURCE RECOVERY FACILITY

Trucks enter the tipping area(1) and unload into the refuse pit(2). From the crane cabin(3) an operator controls a crane(4) to move waste from the pit to the feeding hopper(5). From this hopper, waste is pushed by a ram feeder(5A) into the combustion chamber(6) and onto the grate(7) where it is burned. Air from fans above and below the grate (8) helps to complete burning in the combustion chamber.

The radiation waste heat boiler(9) is designed to recover heat from the burning of refuse. Steam produced by the boiler can be used directly or fed to the turbine/generator(10) to make electricity.

Ash is removed from the combustion chamber by a ram discharger(11) and taken by a conveyer belt(12) to the residue area.

Flue gases from the boiler pass through a dry scrubber(13) where they are treated with a fine, lime-based spray to remove acid gases. Next, a fabric filter bag house(14) works like a vacuum cleaner to trap any remaining dust and particles and the cleaned gases are exhausted through the stack(15).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GARBAGE TO ASHES

Science and Math

Students will observe how incineration reduces waste and produces emissions.

MATERIALS NEEDED

A one-gallon can with several ventilation holes about 1 inch from the bottom; a piece of metal screen large enough to cover the top of the can; 5 pieces of cardboard, six inches square; masking tape; enough waste to fill a box 6 inches x 6 inches x 6 inches (paper, cardboard, magazine pages, lunch scraps such as orange or banana peels, egg shells, small milk carton, napkins etc.); matches; ruler; student worksheet (one per student)

***WARNING:* THIS ACTIVITY SHOULD BE CONDUCTED OUTSIDE OR IN WELL-VENTILATED AREA (PREFERABLY WITH AN EXHAUST FAN) UNDER CLOSE ADULT SUPERVISION!**

IMPLEMENTATION

Distribute student worksheets and explain that in this lesson they will be burning representative waste items to observe the effects of incineration. Tape cardboard pieces together to form a box with four sides and a bottom. Fill the box with the waste you have collected. Have students calculate the volume of the waste.

volume of waste = length x width x height
volume of waste = 6 in. x 6 in. x 6 in.
volume of waste = 216 sq. inches

Transfer the waste into the 1 gallon can. Light the materials on fire and immediately cover the top of the can with the screen. Observe what comes out of the can while the materials are burning. Have students record their observations in the appropriate area on the worksheet for future discussion. When burning is complete and ashes have cooled, return the ashes to the cardboard box. Spread the ashes evenly on the bottom of the box and measure the depth (height) of the ash layer. Using the same formula as above, calculate the volume of the ash. Now, calculate the difference in the volume occupied by the waste before and after burning.

VOCABULARY

volume
ash
pollution
incinerator
landfill

Discussion: The above experiment has demonstrated that burning waste reduces the volume of that waste.

Is incineration an effective solid waste disposal method? What effect might incineration have on our landfill? (reduced amount of waste being buried, extended landfill life) While the materials were burning, what came out of the can? (black smoke, smoke, air pollution) What problems could this cause? (increased pollutants in the air, harmful chemicals in the air, sickness for people living near the incinerator, odors)

EXTENSION

Repeat the experiment with glass and metals(e.g., cut up pieces of an aluminum can, a few pieces of glass). The volume of waste remaining after burning is considerably larger than the previous experiment. Will removing recyclables such as glass and metals from the waste increase or decrease the effectiveness of the incinerator?

WARNING: DO *NOT* BURN PLASTICS!!!

WORKSHEET – Garbage to Ashes

Calculate the volume of the waste
Volume = length x width x height

length_____

width_____

height_____

Multiply:_____ x _____ x _____

Volume of the waste = _____

What comes out of the can while the waste is burning?
Record your observations here:

Calculate the volume of the ash:

length_____

width_____

height_____

Multiply:_____ x _____ x _____

Volume of the ash = _____

Now let's see how much we have reduced the volume of the waste through incineration:

Volume of waste_____minus the

Volume of ash_____equals_____

Lesson III

NOT IN MY BACKYARD

Siting a Resource Recovery Facility: A Public Hearing
Social Studies and Science

Students will examine a complex social, economic, and environmental problem to determine the advantages and disadvantages for the community.

MATERIALS NEEDED

Instruction sheet for each group of students, worksheet for each Town Council member.

IMPLEMENTATION

Tell students that they are going to role-play a town meeting in which an important decision must be made. Explain that the town has a solid waste disposal problem and is considering construction of an incinerator/resource recovery system to alleviate the problem. Students will conduct a town meeting to decide whether or not the incinerator should be built.

Divide the class into five groups. Four of the groups will represent specific interest groups testifying at this public hearing. The fifth group will represent the Town Council whose responsibility it is to hear the testimony and make a final determination on siting the resource recovery facility. Assign a role to each group and distribute the appropriate instruction sheets.

Explain that one representative from each group will present the group's position and concerns to the Council. Each Town Council member will be allowed to ask questions of the group following the presentation. After all of the position statements, a block of time for the groups to question each other and for general discussion will be provided. Allow time for discussion and selection of a group spokesperson. Depending on the amount of background information your students possess, you may wish to extend the lesson to allow further group work and/or library research or you may proceed with the hearing.

When the groups are ready to make their presentations, assemble the entire class and have the Town Council members sit facing them. The meeting is called to order by the Council Chairperson. Each group spokesperson presents a position statement. After questions and discussion, the Council votes on the proposal to site the facility

If time constraints are a concern, it may be necessary to limit the number of questions asked by each Council member or to limit the discussion. You may wish to have an initial hearing at which no decision is reached. Have each group do research and present new, more detailed information at a subsequent Council meeting.

VOCABULARY
incinerator
pollution
resource recovery
dioxin
landfill
recycling
toxic
compost

SITING A RESOURCE RECOVERY FACILITY: A PUBLIC HEARING
GROUP I – SAVE THE EARTH

The Town Council plans to build a Resource Recovery Facility (RRF) to solve the solid waste disposal problem in our town. They have also proposed a law which will require people to recycle certain things. Under the law, each household would separate aluminum cans and newspaper from the rest of their waste. These things would be picked up and brought to a processing site near the RRF where they would be sorted and sold. The rest of the waste would be burned. Heat from the waste could be used to produce steam. In turn, the steam could make electricity. The power produced could be used on site or it could be sold to the local power company. The production of electricity would help pay for the cost of running the RRF. Since burning waste reduces its volume, the landfill would receive less waste each day. It would be able to stay open for several more years.

You are a member of a group that is opposed to the Resource Recovery Facility because:

1) There is a chance that the smoke and ash from the burning waste will contain toxic substances. You are worried about dioxins.

2) The town has not discussed the problem of toxics in the ash. After the waste has been burned, the ash will be buried in the landfill.

3) There will be a large amount of dust and noise pollution from truck traffic

4) Community members have not made a firm commitment to reduce their solid waste. Careful shopping, composting of yard and kitchen waste and recycling are all things people must start doing.

You support recycling but think the Town Council has not gone far enough. You want the law to require separation of all glass, metal and plastic food and beverage containers. You think the town should have a composting program. Perhaps the town should ban the sale of non-recyclable items in local stores.

READ AND DISCUSS THE POSITION THAT YOUR GROUP REPRESENTS. OUTLINE YOUR PRESENTATION AND CHOOSE ONE MEMBER OF YOUR GROUP TO SPEAK TO THE TOWN COUNCIL.

SITING A RESOURCE RECOVERY FACILITY: A PUBLIC HEARING
GROUP 2 – NEIGHBORS UNITED

The Town Council plans to build a Resource Recovery Facility (RRF) to solve the solid waste disposal problem in our town. They have also proposed a law which will require people to recycle certain things. Under the law, each household would separate aluminum cans and newspaper from the rest of their waste. These things would be picked up and brought to a processing site near the RRF where they would be sorted and sold. The rest of the waste would be burned. Heat from the waste could be used to produce steam. In turn, the steam could make electricity. The power produced could be used on site or it could be sold to the local power company. The production of electricity would help pay for the cost of running the RRF. Since burning waste reduces its volume, the landfill would receive less waste each day. It would be able to stay open for several more years.

You are a member of a group of people who live in the neighborhood where the Resource Recovery Facility is to be built. You are opposed to the facility because:

1) You think that the presence of the Resource Recovery Facility will lower the value of your property.

2) The truck traffic will disturb your quiet neighborhood.

3) You are concerned about the effect of air and noise pollution on your family's health.

You are also against the proposed recycling program because:

1) Separating the trash is too much work.

2) You have no place to store the things until they are picked up.

3) Extra garbage services will cost more money. That will mean an increase in your taxes.

READ AND DISCUSS THE POSITION THAT YOUR GROUP REPRESENTS. OUTLINE YOUR PRESENTATION AND CHOOSE ONE MEMBER OF YOUR GROUP TO SPEAK TO THE TOWN COUNCIL

SITING A RESOURCE RECOVERY FACILITY: A PUBLIC HEARING
GROUP 3 – RESOURCE RECOVERY INC.

The Town Council plans to build a Resource Recovery Facility (RRF) to solve the solid waste disposal problem in our town. The have also proposed a law which will require people to recycle certain things. Under the law, each household would separate aluminum cans and newspaper from the rest of their waste. These things would be picked up and brought to a processing site near the RRF where they would be sorted and sold. The rest of the waste would be burned. Heat from the waste could be used to produce steam. In turn, the steam could make electricity. The power produced could be used on site or it could be sold to the local power company. The production of electricity would help pay for the cost of running the RRF. Since burning waste reduces its volume, the landfill would receive less waste each day. It would be able to stay open for several more years.

You are part of the engineering firm which plans to build the Resource Recovery Facility. You are in favor of the project because:

1) It will make a positive contribution to the community by reducing the solid waste problem. Electricity will be produced and many jobs will be created.

2) The problem of toxic substances can be avoided by burning the waste at the proper temperatures.

3) Air pollution can be controlled by pollution control devices built into the smoke stacks.

4) Dust and noise can be controlled by building paved roads that go around, not through, residential areas. Construction of noise barriers such as rows of trees would also help.

Your company also favors recycling because both aluminum and newspaper can cause problems for the RRF. Aluminum does not burn well. Newspaper contains heavy metals which contaminate the ash. You know that selling these things will produce money to help pay for extra disposal costs. You would not oppose recycling more items.

READ AND DISCUSS THE POSITION THAT YOUR GROUP REPRESENTS. OUTLINE YOUR PRESENTATION AND CHOOSE ONE MEMBER OF YOUR GROUP TO SPEAK TO THE TOWN COUNCIL.

SITING A RESOURCE RECOVERY FACILITY: A PUBLIC HEARING
GROUP 4 – ENVIRONMENTAL QUALITY CONTROL

The Town Council plans to build a Resource Recovery Facility (RRF) to solve the solid waste disposal problem in our town. They have also proposed a law which will require people to recycle certain things. Under the law, each household would separate aluminum cans and newspaper from the rest of their waste. These things would be picked up and brought to a processing site near the RRF where they would be sorted and sold. The rest of the waste would be burned. Heat from the waste could be used to produce steam. In turn, the steam could make electricity. The power produced could be used on site or it could be sold to the local power company. The production of electricity would help pay for the cost of running the RRF. Since burning waste reduces its volume, the landfill would receive less waste each day. It would be able to stay open for several more years.

You work for the state agency which is responsible for managing solid waste. The agency is concerned about the disposal crisis in your town. You support the construction of a Resource Recovery Facility because:

1) The town cannot site a new landfill. Current landfill space is quickly filling up. A Resource Recovery Facility will reduce the volume of waste coming into the existing landfill by 85%. This will extend the life of the landfill.

2) Energy recovery will help to offset rising fuel prices.

3) A properly operated RRF should not create environmental problems.

You are also in favor of recycling because:

1) It is a good way to conserve natural resources.

2) The RRF will work more efficiently and safely if recyclables are removed.

3) New jobs will be available in the recycling program.

READ AND DISCUSS THE POSITION THAT YOUR GROUP REPRESENTS. OUTLINE YOUR PRESENTATION AND CHOOSE ONE MEMBER OF YOUR GROUP TO SPEAK TO THE COUNCIL.

SITING A RESOURCE RECOVERY FACILITY: A PUBLIC HEARING
GROUP 5 – THE TOWN COUNCIL

The Town Council plans to build a Resource Recovery Facility (RRF) to solve the solid waste disposal problem in our town. They have also proposed a law which will require people to recycle certain things. Under the law, each household would separate aluminum cans and newspaper from the rest of their waste. These things would be picked up and brought to a processing site near the RRF where they would be sorted and sold. The rest of the waste would be burned. Heat from the waste could be used to produce steam. In turn, the steam could make electricity. The power produced could be used on site or it could be sold to the local power company. The production of electricity would help pay for the cost of ruuning the RRF. Since burning waste reduces its volume, the landfill would receive less waste each day. It would be able to stay open for several more years.

You are the elected members of the Town Council. You must listen to both sides of the issue. Some groups have concerns about the construction of the Resource Recovery Facility. Others have reasons to support it. As they speak, you should take notes on the important points raised on each side of the issue. It is your responsibility to decide whether or not to build the facility. Your decision must be the best for all of the people in your town.

Choose one member of your group to be the Chairperson. It will be that person's job to call the hearing to order. Then, he or she must call upon each of the groups to present information either for or against the RRF. Members of the Town Council will have a chance to question each speaker after he or she presents a position.

SITING A RESOURCE RECOVERY FACILITY: A PUBLIC HEARING TOWN COUNCIL WORKSHEET

	WHAT ARE THEY IN FAVOR OF?	WHAT ARE THEY OPPOSED TO?	IDEAS FOR A COMPROMISE?
GROUP 1 –			
GROUP 2 –			
GROUP 3 –			
GROUP 4 –			

INCINERATION

VOCABULARY

ash – the material remaining after something is completely burned

compost – decayed organic waste; it changes into humus(rich soil) which can then be used for fertilizer

dioxin – a toxic chemical

emissions – substances discharged into the air as a result of burning

energy – power

incinerate – burn to ashes

incinerator – a container in which burning takes place

landfill – a place where solid waste is disposed of by spreading it in thin layers and covering it with soil at the end of each day

pollution – the contamination of soil, water or the air by the discharge of waste, gases or chemicals

recycling – to use something over again; often by collecting and processing a waste product for use as a raw material

resource recovery – a process where energy is produced by burning solid waste

solid waste – trash and garbage

toxic – poisonous

volume – capacity of a container

INCINERATION

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OSCAR'S OPTIONS
UNIT VII
COMPOST

COMPOST

OBJECTIVES

1. Students will be introduced to the concept of compost as a resource, a source of nutrients and a positive by-product of our waste.

2. Students will construct an outdoor composting container and observe what happens to organic wastes.

3. Students will study the heat generation which occurs in composting.

4. Students will understand the functions of the earthworm and its relation to the soil and recognize that animal recycling of organic wastes improves soil structure.

5. Students will identify the microorganisms responsible for the compost process.

6. Students will demonstrate the effects of different soils on plant growth and observe that compost can be used as soil in students' gardens at home.

COMPOST

ACTIVITIES

I.	Composting Magic	Introduction and Reading
II.	Building a Bin	Outdoor Science Activity
III.	The Heat Is On	Math and Science Activity
IV.	The Earthworm Does the Work	Science Activity
V.	Microorganisms: Small but Mighty!	Science Activity
VI.	Going to Make This Garden Grow	Science Activity

COMPOST

TEACHER INFORMATION

These lessons were written with Grades 4 - 8 in mind. All student materials are written at a 6th grade reading level. The lessons in this unit are arranged sequentially, but individual lessons may be taught or deleted as best suits you and your class.

POSSIBLE IMPLEMENTATION OF LITTER UNIT

Monday	I.	Introduction and Reading	20 min.
Tuesday	II.	Outdoor Science Activity	30 min. plus followup
Wednesday	III.	Math and Science Activity	20 min. plus followup
Thursday	IV.	Science	20 min. plus followup
Friday	V.	Science	20 min. plus followup
Monday	VI.	Science	20 min. plus followup

Lesson I

COMPOSTING MAGIC

Introduction and Reading Activity

Students will be introduced to the concept of compost as a resource, a source of nutrients and a positive by-product of our waste.

MATERIALS NEEDED

"Composting Magic" (one per student)

BACKGROUND

Composting is the oldest form of recycling. It is based on the scientific principle that nothing ever really disappears, but just changes shape and takes on new forms. When a leaf falls and begins to decompose, it is broken down by time, weather, insects and worms. The same is true of the waste we throw away every day – from grass clippings and banana peels to eggshells and apple cores. These materials can be set aside to be used as fertilizer for farms and gardens.

Compost is formed through the action of certain microbes that proliferate when mixed organic refuse receives sufficient air and water. These bacteria, which generate a temperature of 150 degrees, literally cook the wastes. The finished product, called compost or humus, is an excellent fertilizer and looks just like soil. It is high in carbon and nitrogen, which are important sources of food for plants and vegetables. In addition to being clean, safe and thrifty, composting can also significantly reduce the volume of solid waste generated by a household.

IMPLEMENTATION

Distribute student worksheets, have students read the information and then apply it to the items listed to categorize them properly. Discuss their answers and lead them to recognize that natural materials are more likely to decompose easily, whereas manmade or processed materials tend to take a very long time to break down.

VOCABULARY

compost
bacteria
decompose
nutrient
humus

COMPOSTING MAGIC

So you have some coffee grounds, banana peels and eggshells and you're about to put them in the trash. When you mow the lawn or rake the leaves, you always clean up with plastic trash bags. Think you're doing a good deed for our environment? Think again!

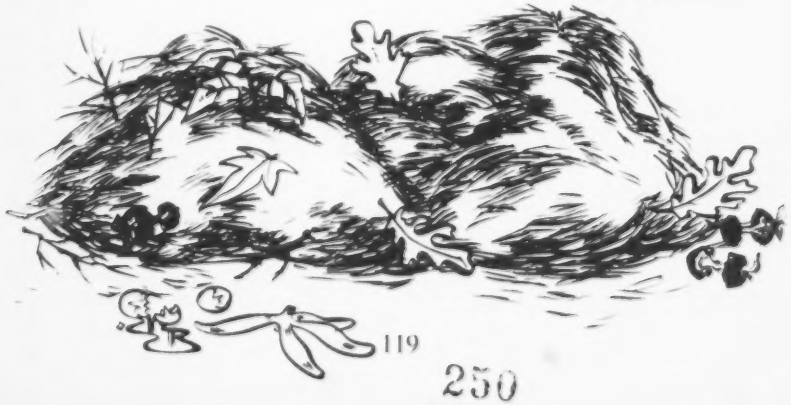
All those things, plus many more, can go right back on the ground. Mix them with dirt and water and plenty of time. Soon, like magic, you'll have something brand new – compost!

Compost is soil that is rich in nutrients. You can use it to feed houseplants or your garden. Chemical fertilizers won't be needed.

How does garbage turn into compost? Bacteria work to break the garbage down into tiny pieces. Over time, most natural materials will break down. Their nutrients enrich the compost. Most manmade things are not easily composted. Plastics, glass, cans and tires take years and years to break down. Meat, bones, and fatty foods must also go into the trash can because they decompose too slowly. Fats also create offensive odors.

THINK ABOUT YOUR FAMILY'S TRASH. WHERE SHOULD YOU PUT EACH THING?

COMPOST PILE (breaks down easily)		TRASH CAN (breaks down poorly)
soda can_____	apple core_____	sandwich bag_____
twigs & leaves_____	juice bottle_____	plastic cup_____
old tire_____	old pen_____	watermelon rind_____
used razor_____	weeds_____	grass clippings_____
leftover salad_____	uneaten rice_____	styrofoam egg carton_____



BUILDING A BIN

Outdoor Science Activity

Students will construct an outdoor composting container and observe what happens to organic wastes.

MATERIALS NEEDED

Site where organic debris can be piled (a small length of chicken wire, a wooden box or garbage can may be used), shovel or pitchfork, organic debris suitable for composting, student reading sheet (one per student)

BACKGROUND

The compost pile is really a teeming microbial farm. Bacteria start the process of decaying organic matter. They are the first to break down plant tissue and also the most numerous and effective composters. Fungi and protozoans soon join the bacteria and somewhat later in the cycle, centipedes, millipedes, beetles and earthworms do their part.

Anything growing in your yard, as well as most table scraps, is potential food for these tiny decomposers. Carbon and nitrogen from the cells of dead plants and dead microbes fuel their activity. The microorganisms use the carbon in leaves or wood wastes as an energy source. Nitrogen provides the microbes with the raw element of protein to build their bodies.

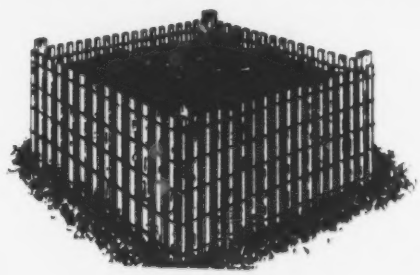
The more surface area the microorganisms have to work on, the faster the materials will decompose. It's like a block of ice in the sun – slow to melt when it's large, but melting very fast when broken down into smaller pieces. Yard and table wastes need to be fairly small (1″ pieces) in order to decompose easily.

The microbes in the compost, like most life on Earth, need a certain amount of air and water. They function best when the compost materials are about as moist as a wrung out sponge, and are provided with many air passages.

IMPLEMENTATION

Choose an out of the way site for your compost pile. The materials may be placed in a heap, a pit, a barrel, wooden box, or chicken wire enclosure. If you use a container, be sure to make openings in the sides and bottom for proper aeration. An enclosure or bin can also be constructed to contain the composting materials (Fig. 1). If a bin is used, no floor is needed and one side is left open for easy access.

Figure 1



Any of the following materials can be composted:

kitchen waste (food scraps, coffee grounds, eggshells etc.)
yard wastes (leaves, twigs, grass clippings)
straw
sawdust
manure
newspaper (in 1" pieces)
ashes
hay

The decomposition process will be accelerated if these items are chopped or shredded before adding them to the compost pile. Chopping and shredding increases the surface area and provides more space for decomposers to feed and grow. Materials may be added whenever they become available, however, do not add any one substance too thickly. Another method is to arrange the materials in layers (see Fig. 2). In either case the pile must be turned and mixed with a shovel periodically (about once a week) so that the decomposition is complete. Oxygen destroys disease-producing bacteria and keeps the environment odor-free. Decomposer organisms require moist, not soggy conditions. Too much water would keep air from getting to the waste materials, slowing the rate of decomposition. Materials can be sprinkled with water when added to the pile. Add water whenever the pile appears too dry, about every two weeks.

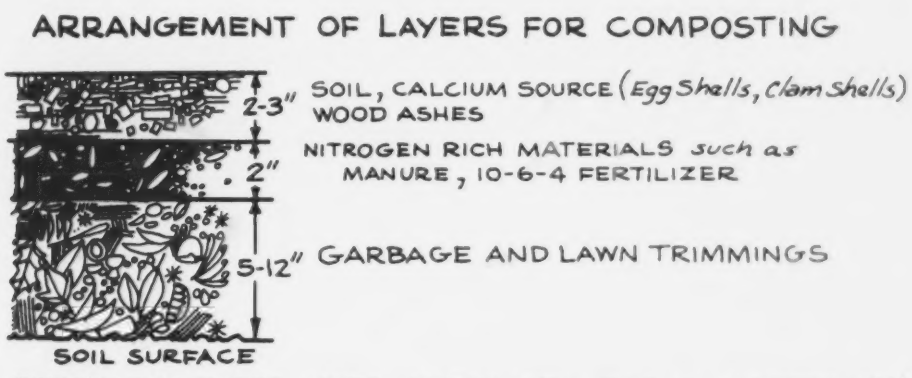
Your compost is ready to use when the material appears finely divided, crumbly, and darker in color. Use it as mulch around trees or shrubs in your schoolyard, applying it several times a year. Mix it thoroughly with soil for gardens or potted plants.

By returning the compost to the soil, you are truly part of the ecological community. Waste materials are reused and organic matter and nutrients are recycled. You are also doing your part to help solve the solid waste problem in your community.

VOCABULARY

composting
compost
decompose
organic

Figure 2



IT'S A NATURAL

In the forest, there is no garbage disposal. No weekly pickup occurs. Leaves, grasses, branches and ferns all die and fall to the forest floor. Nobody picks them up and carts them away. They stay on the ground, but they don't stay the same. They decompose. That means that they break down into the materials of which they are made. The leaves from the trees eventually rot and add their nutrients to the forest floor. Even dead animals decompose, as insects and worms break them down. There's no waste here. The forest's waste material is used to build up the soil so that more things can grow.

A lot of the garbage that we take to landfills is in the form of yard wastes and food wastes. Organic wastes like grass clippings, lettuce leaves and corn husks all get thrown away. But we don't have to put these wastes into a landfill to be buried. We can build with them, just like the forest does.

Lesson III

THE HEAT IS ON

Math and Science Activity

Students will study the heat generation which occurs in composting.

MATERIALS NEEDED

2 buckets, soil, water, organic materials, thermometer, student worksheet (one per student)

IMPLEMENTATION

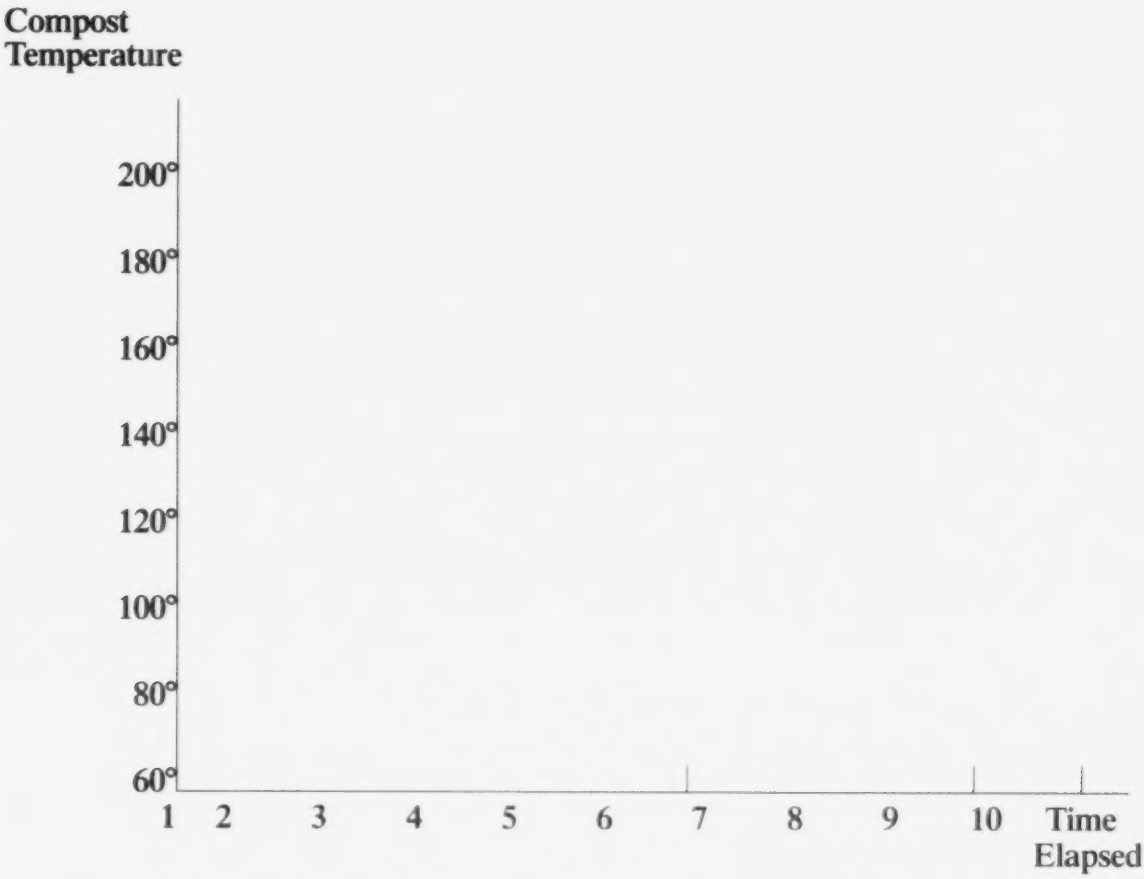
Form a compost mixture in a bucket by adding alternating layers of organic material and soil. The organic layers should be about 3″ deep and the soil layers should be about 1″ deep. Use any available organic matter – such as food scraps, dry leaves and bits of paper. Keep the compost mixture moist but not waterlogged. (Excessive water will block aeration, creating anaerobic decomposition, which in turn leads to undesirable odors.) To provide aeration, the mixture should be turned every four or five days by transferring the mixture to another bucket.

Each day, insert a thermometer into the center of the compost pile and record the temperature. Mark the temperatures on a graph, with the temperature plotted against time in calendar days. This may be done on an individual basis, or as a whole class activity. (Note: after three weeks, it may be more convenient to record your results as temperature plotted against time in weeks.)

SOURCE

Teaching Resource Recovery in the Classroom

NAME_____



Think about it: Why does the temperature start at 60°, not 0°?

Lesson IV

THE EARTHWORM DOES THE WORK

Science Activity

Students will understand the functions of the earthworm and its relation to the soil, and recognize that animal recycling of organic wastes improves soil structure.

MATERIALS NEEDED

2 terrariums or glass containers, earthworms, soil, leaves

BACKGROUND

The earthworm consumes its own weight in leaves and grass every 24 hours. It returns nutrients to the soil. Worm castings contain minerals. Worm tunnels open spaces for roots and water. Worms cannot hear or see, but they are sensitive to light and vibrations. They will eat dead leaves, twigs and insects and, in turn, are eaten by some birds and burrowing animals.

IMPLEMENTATION

Share background information on worms with students prior to setting up two containers with leaves, soil, sand, and clay. Terrariums or large glass jars are excellent containers as they allow students to easily observe what is occurring.

Ask students to collect worms outside or bring them from home. Place the worms in only one of the containers. Keep the soil of this container slightly moist.

Describe and draw pictures of the soils of both containers. Ask the students to predict what will happen to the soils.

Cover the worm container with black cloth or paper. Allow air holes for breathing.

After three to four days, remove the paper and observe the worms and soil layers. Compare the soil in the two containers.

Continue to observe the activities of the worms. Notice the differences between the contents of the two containers. While the leaves in the "wormless" container will begin to break down, they will decompose more slowly. Discuss how the worm is able to recycle materials by digesting dead material and returning it to the soil. When finished, return worms to soil in an outside garden.

SOURCE

Project Learning Tree

Lesson V

MICROORGANISMS - SMALL BUT MIGHTY!

Science Activity

Students will identify the microorganisms responsible for the compost process.

MATERIALS NEEDED

Two trays, soil, organic matter, 12 slides, water, gentian violet or methylene blue, erythrosine or eosine, microscopes, wax pencil

IMPLEMENTATION

Fill one tray with dry soil and the other with soil containing about 5% organic matter. Prepare the latter by thoroughly mixing ground-up organic matter with dry soil. Make a slit in the soil and insert a clean microscope slide. Press the soil against the slide. Following this procedure, insert six slides into each container, as in Figure 1.

Figure 1

Six slides in each container will permit observation of each sample at the end of one, two and three weeks. Each observation requires two slides, one stained dark and one stained light. Adjust the moisture content to about 20% water by adding a volume of water corresponding to about 1/5 of the volume of soil. Keep the moisture content as constant as possible by adding water as needed.

After one week, two slides from each container will be studied according to the following procedure:

Dig soil away from one side of the slide, then tilt the same slide toward the hole and lift it out, as in Figure 2.

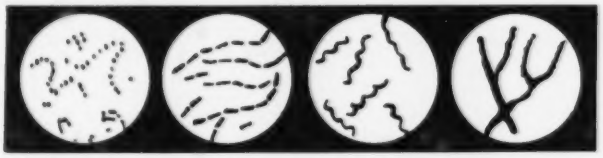
Figure 2

The slide will now have a film of soil and microorganisms on one side. Clean the other side with a cloth. Label the slide with a wax pencil and prepare a second slide in the same way.

The preparation on the slide is "fixed" by passing the slide over a flame – one or two passes should be sufficient.

Stain one slide dark, using gentian violet or methylene blue. Stain the other slide light, using erythrosine or eosine.

Examine each slide for the presence of bacteria with the low and high powers of a microscope. If present, spirilla will probably not be seen unless the field is darker. Sketch the observations and have students compare them to Figure 3 in order to identify the morphological class of the bacteria.



Cocci Bacilli Spirilla Actinomycetes

Figure 3: Common Morphological Classes of Bacteria

Have students determine whether there are differences in the number and types of microorganisms in the two samples.

At the end of the second week, repeat the procedures with another pair of slides from each sample. Have students determine if the number and types of bacteria in the samples have changed significantly and help them to account for the changes.

At the end of the third week, repeat the procedures and make further observations. Have students relate their observations and conclusions to composting.

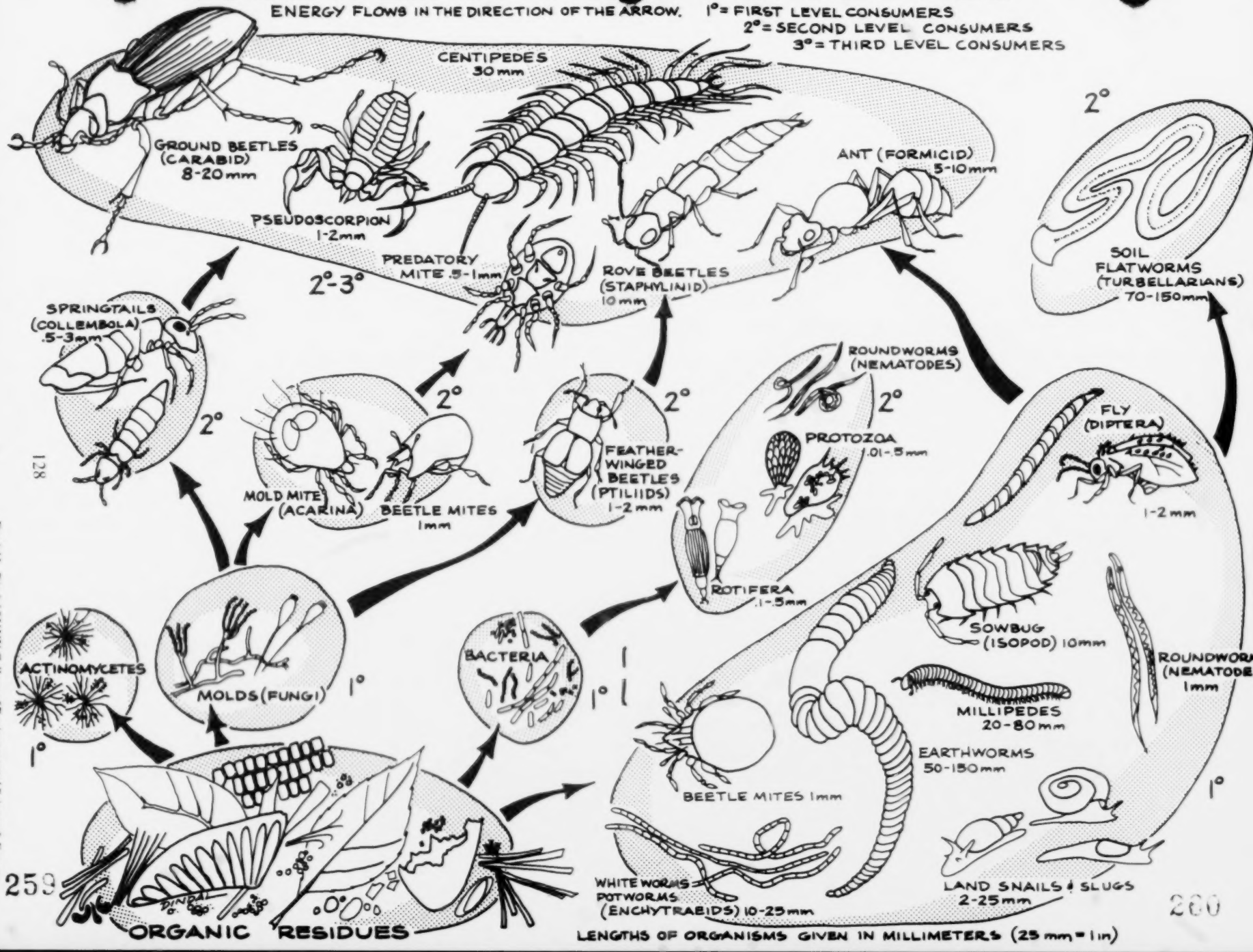
EXTENSION

Share the food web of the compost pile with students. Discuss its ramifications on composting and, if possible, assemble some of the consumers for direct observation.

SOURCE

Teaching Resource Recovery in the Classroom

FOOD WEB OF THE COMPOST PILE



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259

260

Daniel L. Dindal SUNY College of Environmental Science & Forestry.

Lesson VI

GOING TO MAKE THIS GARDEN GROW . . .

Science Activity

Students will demonstrate the effects of different soils on plant growth and observe that compost can be used as soil and in students' gardens at home.

MATERIALS NEEDED

Soil samples (clay, sand, compost, schoolyard soil, commercial potting soil), containers for soil samples and planting seeds (milk cartons etc.), seeds (marigolds, tomatoes or beans work well), plastic wrap, student worksheet (one per student)

IMPLEMENTATION

Help students prepare two identical series of soil samples, using milk cartons or paper cups as containers. Label each container: clay, sand, schoolyard soil etc.

Ask students if they think that adding compost to the soil samples in one set will help the plants to grow better. Record their predictions. Measure and add an equal amount of compost to each soil sample in one set and mix. Label this Set A. Label the plain soils Set B.

Have students plant the same type of seed in each soil sample in both sets. Water, then cover the containers with plastic wrap (to keep seeds moist) until sprouts appear.

Have students complete the chart to compare the soil samples. Discuss results, including growth and appearance. Compare results with predictions

Discuss:

- is soil type important for good plant growth?
- does compost help plant growth?
- can people help their lawns, trees, and gardens by putting compost around them?

EXTENSION

Ask the students to find out:

- the size of their lawn and backyard.
- if their parents rake leaves and grass.
- what their parents do with the raked leaves and grass.
- how long it takes to put a pile of leaves into a bag.

Explain to students that they can make a compost pile in the backyard just like they made in the classroom, using the discarded leaves. Give each student a pamphlet and encourage them to share the information with their parents. If students do begin compost piles at home, encourage them to bring in samples of their finished soil from time to time, for comparative purposes.

NAME _____

SET A	first growth	height day 2	height day 3	height day 4	height day 5	height day 6	height day 7	height day 8	height day 9	Observations
CLAY										
SAND										
COMPOST										
SCHOOL SOIL										
POTTING SOIL										
SET B										
CLAY										
SAND										
COMPOST										
SCHOOL SOIL										
POTTING SOIL										

COMPOST

VOCABULARY

bacteria – single-celled living organisms that can cause disease; they also can break down solid waste

compost – decayed organic waste which changes into humus (rich soil) and can then be used for fertilizer

composting – the process of producing compost

decompose – to break down, change form

humus – decayed plant or animal matter; rich soil

nutrient – decayed plant or animal matter which enriches the soil

organic – made from living organisms

COMPOST

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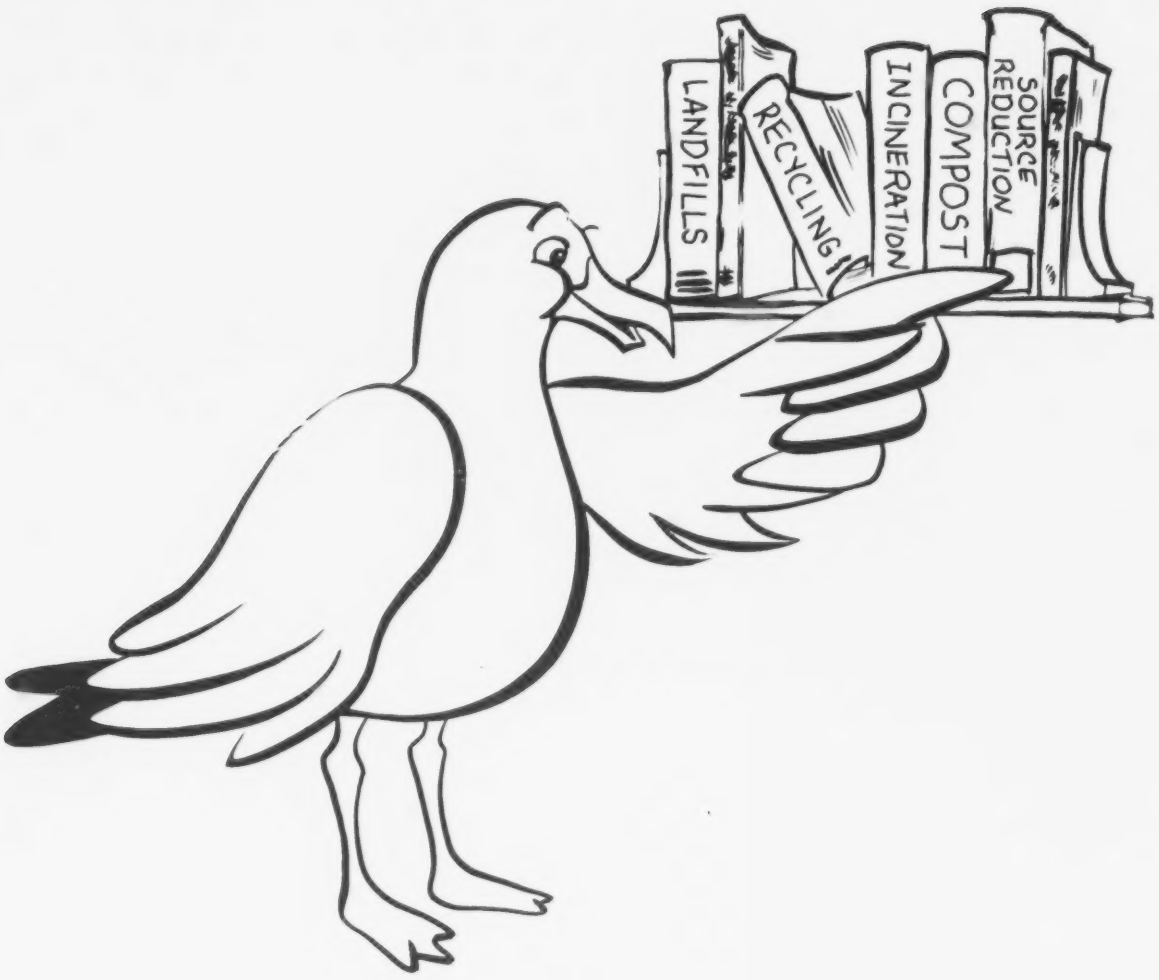
OSCAR'S OPTIONS
UNIT VIII
SOURCE REDUCTION



SOURCE REDUCTION
Introduction

Source reduction refers to those practices which reduce waste through selection of products which are durable, re-useable, repairable and/or recyclable. Consumers need to know that the choices they make have direct environmental consequences. Certain products or classes of products are preferable from an environmental standpoint, both in the processes of manufacturing and in the disposal methods required.

When most people lived on farms, food moved directly from the field to the table. There were no commercials, no grocery stores, and no packages to open. Leftovers were fed to the animals or made into compost to fertilize the fields again. In today's urban communities, a majority of our food is purchased in supermarkets, wrapped and packaged for safety and convenience. The leftovers include not only the food wastes, but the plastic, paper and metal containers in which the food was purchased.

Today, nearly $1 of every $10 Americans spend for food and beverages pays for packaging. Preliminary figures released by the U.S. Department of Agriculture indicate that Americans spent more for food packaging in 1986 than the nation's farmers received in net income. In the interest of speed and convenience in food preparation, plastic bags and bottles, metal cans, glass jars, cardboard and paper containers swell the waste stream. The average American discards about 662 pounds of packaging every year. This figure is expected to continue to increase by 20 pounds per person per year.

Frequent stylistic and technological changes as well as disposable products, deliberately designed for a single or very limited use before disposal, contribute to our throwaway lifestyle. Henry Ford wanted to serve his customers by producing cars that "as far as we can provide, will last forever." Simplicity and durability became less desirable qualities when the big profits came from the sales of new products. Soon General Motors President Alfred Sloan stated, "we want to make you dissatisfied with your current car so you will buy a new one." A whole new industry developed around the concepts of planned obsolescence and consumer manipulation. Now, our desires, indeed our needs, are often products of a marketing executive's imagination. Self conscious wastefulness underlies the garbage crisis.

Of course we cannot return to the farm, but we can become environmentally conscious consumers. We can put durability and/or ease of recycling higher on our list of priorities. We can make choices for the environment rather than for our personal convenience. It is not always easy to change our attitudes and behaviors, but the consumer choices we make today will have a direct effect on the quantity of waste we must dispose of tomorrow.

SOURCE REDUCTION

OBJECTIVES

1. Students will be introduced to the concept of source reduction and will understand that consumer choices may have direct environmental consequences.

2. Students will determine whether environmental value decisions affect consumer choices.

3. Students will become aware of social, economic, legislative and emotional issues in resource conservation.

SOURCE REDUCTION

ACTIVITIES

I.	Waste Not, Want Not	Reading and Creative Thinking Activity
II.	To Market, To Market	Language Arts and Social Studies Activity
III.	To Save a Tree	Social Studies Activity Values Discussion

SOURCE REDUCTION

TEACHER INFORMATION

These lessons were written with Grades 4 - 8 in mind. All student materials are written at a 6th grade reading level. The lessons in this unit are arranged sequentially, but individual lessons may be taught or deleted as best suits you and your class.

POSSIBLE IMPLEMENTATION OF SOURCE REDUCTION UNIT

Monday:	I.	Reading and Creative Thinking Activity	30 min.
Tuesday:	II.	Social Studies Activity	45 min.
		Homework: Survey	20 min.
Wednesday:	II.	Social Studies Follow-up	45 min.
Thursday:	III.	Social Studies Values Discussion	45 min.

Lesson I

WASTE NOT, WANT NOT

Reading, Creative Thinking

Students will be introduced to the concept of source reduction and will understand that consumer choices may have direct environmental consequences

MATERIALS NEEDED

"Waste Not, Want Not" (one per student),"Be a Concerned Consumer" (one per student)

IMPLEMENTATION

Distribute "Waste Not, Want Not" and allow time for students to read the information. Discussion could focus on how planned obsolescence and advertising affect our behavior as consumers. Disposable products that encourage waste is another potential topic. Ask students to suggest ways that they could change their habits to reduce waste. Distribute "Be a Concerned Consumer". Read and discuss the suggestions. Ask students to share this list with their families and to return to class with information about family reaction to the suggestions. Share this information as a class.

VOCABULARY

compost
convenience
durable
fertilize
manufacture
planned obsolescence
source reduction

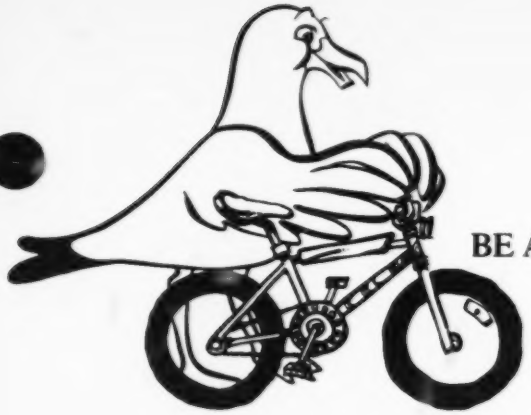
WASTE NOT, WANT NOT

Did you know that what you buy can have an effect on your environment? Some products are made in a safe way; others are not. Some will last a long time; others are quickly consumed. Some products can be easily repaired or recycled; others are difficult to dispose of. You can choose products that are not harmful to the environment. Choosing a certain product because it creates less waste is called source reduction.

One huge source of waste is packaging. The average American now throws away over 600 pounds of packaging each year. When most people lived on farms, food moved directly from the field to the table. Leftovers were fed to the animals or made into compost to fertilize the fields. Today, most of our food comes from the supermarket. It is wrapped and packaged for safety and convenience. Now, the leftovers include the plastic, glass, metal and paper that the food came in.

Sometimes we buy things we don't need just to be in style. Companies advertise the latest cars, toys and clothes. They try to make us unhappy with what we have, so we will buy something new. Soon, that new product is replaced by something else. The old ones, even if still useful, often end up in the trash. Manufacturers could make basic products that are simple and durable.

We have choices. We can buy only products that are manufactured safely. We can buy things that last. We can try to be less wasteful. The choices we make today create the waste we must dispose of tomorrow.



BE A CONCERNED CONSUMER

You *DO* Have a Choice

1. Shop for durability. Buy products with long-term value. Read and evaluate the warranty.

2. Look for products in recyclable, returnable or refillable containers whenever possible. Buy soda in easily recycled aluminum cans or returnable bottles rather than the more problematic plastic bottles.

3. Avoid excessive packaging. Buy products in bulk and in larger sizes. For example, a seven ounce tube of toothpaste uses 50% less packaging per ounce than the three ounce size.

4. Avoid disposables such as throwaway pens, lighters, razors. Some disposable items actually cost more than their more durable counterparts. 90 cloth diapers from a diaper service cost about $10 per week. The same number of disposable diapers cost at least $16 per week.

5. Support recycling. Separate your cans, bottles and newspapers. Encourage your friends and neighbors to do the same.

6. Buy products packaged in recycled paper and carry them home in paper bags. In fact, buy recycled paper for all your paper needs.

7. Use less paper. Turn the paper over – use both sides. Make memo pads or scratch paper from discards. Ask yourself if you really need ten copies.

8. Buy products that can be repaired. Avoid those that carry the label "no owner serviceable parts."

9. Consider reuse of purchases. How about batteries that can be recharged? Children's clothing or toy exchanges? Yard sales?

Lesson II

TO MARKET, TO MARKET

Language Arts, Social Studies

Students will determine whether environmental value decisions affect consumer choices.

MATERIALS NEEDED

"To Market, To Market" survey (two or more copies per student)

IMPLEMENTATION

Explain to students that choices we make in our daily lives affect the amount of waste we produce. Have students fill in the questionnaire and score themselves. Discuss the results. Are they concerned consumers?

Now, ask them to take the survey home and administer it to one or more adults (parents, grandparents, neighbors). Ask them to return to class with the completed forms. When all of the surveys are in, tabulate the results.

Discuss with students the importance of environmental issues for consumers. How does this affect the amount of solid waste we create?

EXTENSION

Share the results of the survey with your local newspaper and/or city and state legislators. Create posters, video commercials, advertisements on ways to reduce waste.

TO MARKET, TO MARKET
Consumer Survey

Every day we make choices which affect the amount of waste we produce. Take a few minutes to consider your contribution to Rhode Island's solid waste stream. Add up the circled numbers in each column to find your total score. Use the information on the next page to see if you are a concerned consumer.

Do You	NEVER	SOME-TIMES	OFTEN
1. consider whether you really need something before you purchase it?	3	2	1
2. think about what will happen to a product or package when you no longer have any use for it?	3	2	1
3. try to reuse things you already have instead of disposing of them and buying new things?	3	2	1
4. consider what pollution and wastes were created in the manufacture of the things you buy?	3	2	1
5. take advantage of the opportunities to recycle in your area?	3	2	1
6. shop at second-hand stores or garage sales?	3	2	1
7. use dishcloths or sponges instead of disposable paper products which can't even be recycled?	3	2	1
8. avoid items such as disposable diapers, razors or lighters when longer lasting alternatives are available?	3	2	1
9. avoid eating in carry out places which wrap your food in lots of paper and plastic or ask that less wrapping be used for **your** order?	3	2	1
10. compost kitchen waste and other decomposable organic matter?	3	2	1
11. spend the money to repair an item even though you could get a new one for nearly the same price?	3	2	1
12. talk to store managers about stocking bulk products or avoiding packaging?	3	2	1
13. complain to manufacturers about "built-in obsolescence"?	3	2	1
14. write to government officials and leaders expressing your concerns about the need to produce less wasteful products?	3	2	1
15. read consumer information articles to find out about the quality and durability of products you buy?	3	2	1

☐ + ☐ + ☐ =

Oregon Department of Environmental Quality
Solid Waste Division

grand total _____

275

TO MARKET, TO MARKET
Consumer Survey

IF YOUR SCORE WAS:

40 OR MORE

Like most Rhode Island residents, you are probably contributing your full share of garbage to our rapidly diminishing landfill space, including tons of useable, recoverable materials.

WHAT CAN YOU DO? Be aware of the amount of garbage you have each day. Note how heavy it is. What could be reused, recycled or avoided entirely? Next time you go to the store, check to see if any of the products you normally buy in non-recyclable containers are also available in returnable, refillable or recyclable containers.

BETWEEN 21 AND 39

You are doing some reducing, reusing and/or recycling. These patterns need to be practiced consistently by the majority of the population if we are going to reduce the increasing amounts of waste.

WHAT CAN YOU DO? Do some comparison shopping. Consider various types of packaging and the alternatives which are available. Does it cost more or less to buy reusable or recyclable packages? Take your own paper bags back to the market and reuse them.

20 OR LESS

You've obviously done some serious thinking about the need for resource conservation. It shows!

Think about the things you do to conserve. Which are you the most proud of? Encourage one other person to consider doing the same. Get involved in solid waste planning in your community. KEEP UP THE GOOD WORK!

Lesson III

TO SAVE A TREE

Social Studies, Values Discussion

Students will become aware of social, economic, legislative and emotional issues in resource conservation

MATERIALS NEEDED

"To Save a Tree" worksheet (one per student)

IMPLEMENTATION

Hand out student worksheets and tell them that you are going to discuss ways to save trees. Since trees are a renewable resource, discuss reasons why they need to be saved. You might mention the length of time it takes to grow a tree or the fact that a forest as large as the entire state of Rhode Island is needed to provide the paper products for a fast food restaurant chain for a single year. Ask students to rank the techniques for saving a tree according to which seem the most effective and desirable. This may be done as an individual or a small group activity. Allow sufficient time for students to evaluate and rearrange their choices.

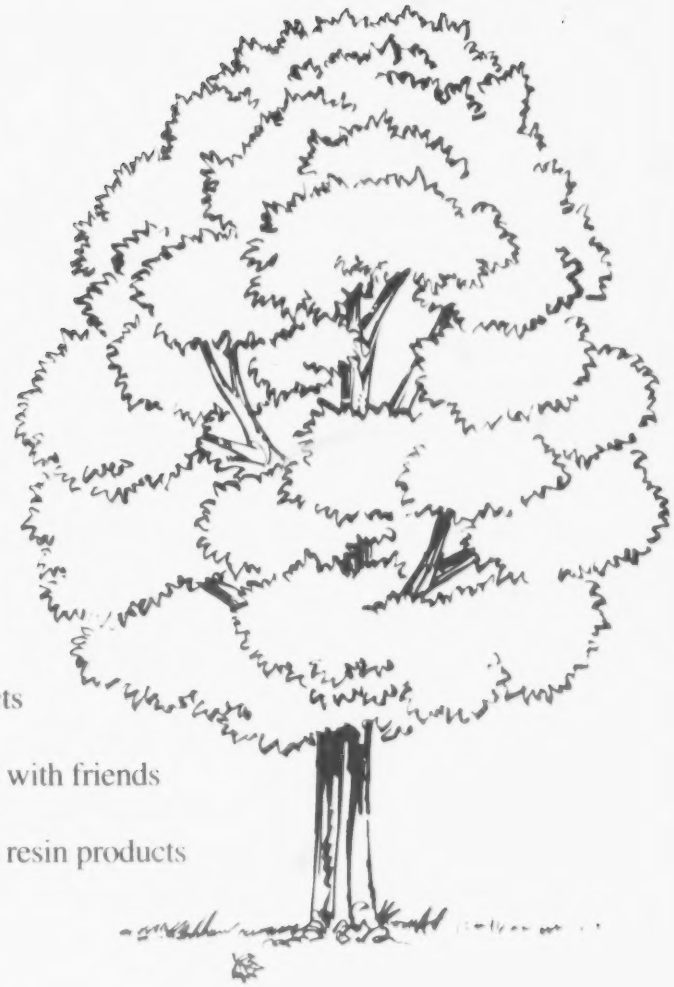
Now, go through the choices with the class. Discuss and evaluate the tradeoffs involved in each technique. For example, using more plastics may create more hard-to-dispose-of waste and the manufacture of plastic uses non-renewable, petroleum-based chemicals. Writing threatening letters may be against the law and it uses more paper. More recycling of paper is good but might put a lumberjack or truck driver out of work. But then, more recycling means more jobs in recycling. Some of the jobs accomplished by spraying could be done by laborers but it would take longer and cost more money. The price of lumber could go up. Then, the price of products made from that lumber like furniture and houses could go up, too. Cotton diapers must be washed and sterilized – energy is used and soap and other washing products go down the drain. Packaging allows products to be kept on the shelf longer. It keeps products clean and separate from one another, but it contributes heavily to the amount of solid waste we must dispose of.

After this discussion, ask students to rank the techniques for saving a tree again. Have their choices changed? If so, why? What major issues remain unresolved? Remind students that there may not be one right answer to environmental issues. Often, there are positive and negative aspects to either side of any question.

VOCABULARY
defoliant
fiber
logging
petroleum
resin
varnish

SOURCE
California Environmental Education Guide, Vol. 4

TO SAVE A TREE



Recycle paper

Recycle wood

Repair wood products that break

Refuse to buy or use wood products

Share your newspapers and books with friends

Don't use varnish and other wood resin products

Close down lumber companies

End defoliant spraying of forests

Close National Forests to logging

Create more National Parks

Start a letter writing campaign to "SAVE the TREES!"

Chain yourself to a tree

Use more plastic and less wood

Substitute cotton and other fiber products for wood (paper) products

Write threatening letters

SOURCE REDUCTION

VOCABULARY

compost – decayed organic waste which changes into humus (rich soil); can be used for fertilizer.

convenience – ease of use, comfort

defoliant – chemical applied to plants causing leaves to drop off

durable – lasting for a long time

fertilize – apply a substance to soil to make it more fertile

fiber – thread that gives texture or substance to paper or fabric

logging – cut down trees for lumber

manufacture – to produce something from raw materials

petroleum – oily liquid used to produce gasoline, motor oil, and many plastic products

planned obsolescence – deliberate design of a product so that it will be out of date in a short period of time

resin – natural, organic substance used in varnish, ink, plastics

source reduction – consumer behavior to deliberately reduce waste through informed choice

varnish – liquid painted on to provide a hard, shiny, transparent surface

SOURCE REDUCTION

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END

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